THE ENGINEER

A Seven-Day Journal

Report on the British Standards Institution

THE report has just been issued of the committee set up by the Board of Trade to consider the organisation and constitution of the British Standards Institution. This committee was appointed because it was estimated that the current annual expenditure of about £220,000 would, with further advances in standardisation, be doubled in the next few years. At present the Institution has some 2000 different technical committees, and is responsible for about 1500 general standards, over 200 special standards and some thirty codes of building practices. The committee considers that industry increasingly recognises the economic importance of standardisation, that it will proceed by consent, and that the B.S.I. will need to be expanded to meet the increase in the volume of work which this growing interest will entail. It is recommended that commercial undertakings should subscribe to the work of the institution on the basis of the number of employees, though this would be intended only as a guide to the sum which should be paid by a firm wishing to contribute its share. A number of detailed recommendations appear in the report, but the main conclusion states that the organisation and constitution of the B.S.I. are in general well adapted for carrying out its present work and the increased work which may be expected to fall on it. It is suggested that the Institution should remain under control of its own council. The increased work will involve increased expenditure and the committee foresees an increase to £350,000 or £400,000 a year by the end of the next five years. It recommends that the Government should make a minimum contribution of £90,000 for the year 1951/52 and thereafter a contribution equal to the income from industrial subscriptions up to a maximum of £150,000. Such a contribution is considered justifiable as the Government is a large purchaser of goods of all kinds and as it represents the public as consumers of goods which might be dearer and less available if there were no standards.

Report on an Express Passenger Train Fire

THE Ministry of Transport report has been published on the investigation into the fire which occurred in an express passenger train near Beattock Summit on June 8, 1950. The train concerned was the 11 a.m. express passenger train from Birmingham to Glasgow Central and as a result of the fire, which was discovered at 4.56 p.m., five passengers lost their lives. Two coaches of the train, the second and third from the engine, which were completely gutted, were of composite steel and wood construction. Although there were no living witnesses to testify to what actually happened, Colonel R. J. Walker considers in his report that he was able to reconstruct, beyond reasonable doubt, a true account of what occurred. After a detailed analysis of the events immediately before and after the fire, Colonel Walker concludes that a lighted match or cigarette, thrown on the floor, found its way under the heater beneath a seat into a collection of dust and odd pieces of paper in the angle formed by the floor and the rear partition, which was made of plain, soft wood. This happened some time before the train reached Carlisle, where the occupant of the compartment, which was empty at the time of the fire, probably left the train. The fire smouldered and formed carbon monoxide and other highly inflammable gases, and eventually burnt a small hole through the partition. Gases and smoke escaped into the next compartment and down the corridor, and were probably noticed by a man, who was one of the victims, in the next coach. This man went forward to warn other passengers but probably whilst a woman and her children were being helped an explosion occurred and the whole of the coach was involved in the fire which followed. The man, two women and two children died in the original explosion. The report recommends that coaches should be so constructed that the whole of the floor area underneath the seats can both be seen and cleaned.

Electrical Research Association Luncheon

THE annual general meeting of the British Electrical and Allied Industries Research Association (the E.R.A.) was held in London on Friday, February 9th, and was followed, as usual, by a luncheon. The need for increased financial support for the Association was referred to in speeches by Sir Archibald Gill who proposed the toast of the E.R.A., and by Sir John Hacking, who responded, as deputy for Lord Citrine, President of the E.R.A. Tracing the origin of the E.R.A. to the early years after the first World War, Sir John said that it was one of the three biggest organisations for central research in Great Britain. He emphasised the need for individual research and central research side by side: even if there were some overlapping of effort the system had the virtue of fostering the competitive spirit. Although the British Electricity Authority proposed to extend its research activities, the work would supplement, rather than conflict with, the E.R.A. programmes. Referring to the extension of the E.R.A. research facilities, Sir John spoke of the Leatherhead project, plans for the first stage of which were completed, at an estimated cost of £400,000 for buildings and equipment. There were plans for further extension if necessary but to implement them would involve substantial extra contributions from the British Electricity Authority and there was need for the Authority and the manufacturers to get together for discussion of the more long-term plans. Speaking of revenue, Sir John said that if, under the new agreement, the D.S.I.R. grant were to be increased by 40 per cent, an extra 70 per cent of income would be required from the industry. The toast of the President was proposed by Mr. H. Astbury, Chairman of the Council of the E.R.A., who expressed satisfaction at the fact that Lord Citrine had accepted the presidency for the second year in succession.

Overhead Transmission Lines in Inverness-shire

THE RIGHT HON. HECTOR MCNEIL, M.P., Secretary of State for Scotland, has confirmed a scheme prepared by the North of Scotland Hydro-Electric Board for the erection of overhead transmission lines in Inverness-shire from Fasnakyle transforming station to a new transforming station, which is to be built near Fort Augustus. The new lines will form a further extension to the grid system in the North of Scotland and they will be connected later to the generating stations of the Garry and Moriston projects. The scheme is estimated to cost £374,000. The Amenity Committee, which was consulted about the possible effects of the scheme on the amenities of the district through which the lines will pass, did not make any recommendations on the scheme. Only one objection was lodged against the scheme and the Secretary of State did not consider it necessary to hold an inquiry, which was not asked for by the objector. A White Paper on the scheme has been published and is available (price 1d.) from H.M. Stationery Office, 13a, Castle Street, Edinburgh, or through any bookseller.

Glasgow and Clyde Shipowners' Association

AT the annual meeting of the Glasgow and Clyde Shipowners' Association, held in Glasgow last week, the retiring president, Mr. W. Tennant Sloan, remarked that the high level of taxation was most discouraging and complained about the action of the Exchequer in insisting on collecting a tax on undistributed profits, which the shipowner had earmarked for special purposes. The money which now went into the coffers of the Treasury only helped to make good the losses incurred by other projects, instead of being available for the provision of new tonnage and so helping to provide continuity of work in the shipyards. Mr. Sloan said that shipowners of other nations were not dealt with so harshly and that their fleets were growing, while in this country the incidence of balancing charges, at a time when the value of money was falling, increased the difficulties of tonnage replacement, especially with rising costs. Discussing the turn round of ships in port, Mr. Sloan stated that the time wasted in port seriously reduced the earning power of the ships.

The End of Oil Substitution

A STATEMENT made on behalf of the Minister of Fuel and Power in the House of Commons, on Monday last, announced the end of oil substitution. The statement points out that towards the end of 1949, when the dollar reserves of the sterling area were very low, the Government decided that action must be taken to reduce the dollar expenditure on oil. The British controlled oil companies expected to have in 1950 more oil than they needed to supply their established markets and it was decided that the United States companies should be required to use this oil in place of oil which they would otherwise have imported from dollar sources. This policy became known as "substitution." Alternative proposals were discussed with the American companies to find out how far and by what methods they could reduce the dollar cost of the oil supplied to the sterling area and bring such costs into line with the average dollar costs of British companies. Last year agreements were made with the Standard Vacuum Oil Company and the California Texas Oil Company and with the Standard Oil Company (New Jersey), and the Socony Vacuum Oil Company, on the disposal of their share of Iraq oil. Further agreements made with the two latter companies have settled all other outstanding issues and the dollar content in the oil distributed by them in, or through, the sterling area should be progressively reduced to the level of the average gross dollar content of oil produced by British companies. Substitution ends at once and in their trade in the sterling area the Jersey and Socony Companies will not be subject to any restrictions which do not apply to British companies. Substitution and the agreements which partially replaced it in 1950 saved the country about 45 million dollars on the oil supplied in that year to the sterling area. The dollar savings on this oil will progressively increase; by 1954 it should be about 250 million dollars a year.

High-Powered "Mallet" Freight Locomotives

By E. C. POULTNEY, O.B.E., M.Inst.Loco.E.

No. I

FOR working important main line freight traffic the Chesapeake and Ohio railway has, during the last few years, placed in service a number of powerful simple expansion "Mallet" type locomotives of interesting design and remarkable for their high power output.

The purpose of this article is to present a description of these locomotives and to give particulars of certain trials carried out with the object of determining their performance on different divisions of the railway when handling exceptionally heavy coal trains.

In the preparation of this article the writer has received considerable assistance from C. B. Hitch, Chief Mechanical Officer, C. and O. Railway, who courteously placed copies of the test reports at his disposal, and from M. J. Donovan, Mechanical Engineer, Lima Locomotive Works, Lima Hamilton Corporation, for the photographs and the drawing reproduced.

Originally designed in 1941, there are now sixty of these engines in service, the first twenty of which were built during 1941 and 1942. In 1944 a further twenty-five were placed on order, and in the latter part of 1948 and the early months of 1950, fifteen more were completed. Engine No. 1650 illustrated is one of the last fifteen to be put into traffic.

These locomotives are all alike so far as the design in general is concerned; in fact, the only difference is that the last fifteen delivered have a slightly different tube and flue arrangement, which has modified the evaporative heating surface and also that of the superheater.

The engines known on the railway as the "Allegheny" type have been designed for maximum speeds of 60 m.p.h., though the primary objective of the design is to develop maximum continuous power output at speeds between the limits of 30 to 35 m.p.h. To meet these specific requirements, certain main features have been incorporated in the design as being essential for economical operation. These may be summarised as follows :—

A boiler working at a high steam pressure with ample heating surfaces and a large grate area.

A steam distribution system designed with a view to high capacity working with minimum loss in steam pressure between the boiler and the engines.

A wheel arrangement suitable for fast running when desired, incorporating for this purpose, coupled wheels of relatively large diameter.

In order to comply with these requirements and obtain a satisfactory distribution of the engine weight, a new form of wheel arrangement has been adopted. This consists of a leading single axle truck and six coupled drivers for the front power unit followed by a further set of six coupled driving wheels in conjunction with a six-wheeled trailing truck for the rear unit. The engines are, therefore, of the 2–6–6–6 type and are, moreover, the first to be constructed with this wheel arrangement. The adoption of a six-wheeled trailing truck in place of the more usual four-wheeled pattern has made it possible to provide a boiler of exceptional size with a grate of considerable proportions, while at the same time restricting the loading on coupled axles so that this is sufficient only to obtain an adhesive factor such as will enable the full rated tractive effort to be developed under all normal operating conditions. This is important because it means that reasonable impact loadings between the wheels and rails due to combined static and dynamic loadings are attained at usual operational speeds.

Principal Dimensions, C. and O., Class "H-8," 2–6–6–6 Type Locomotives.—Locomotives Nos. 1600–1644, Built 1941–1944

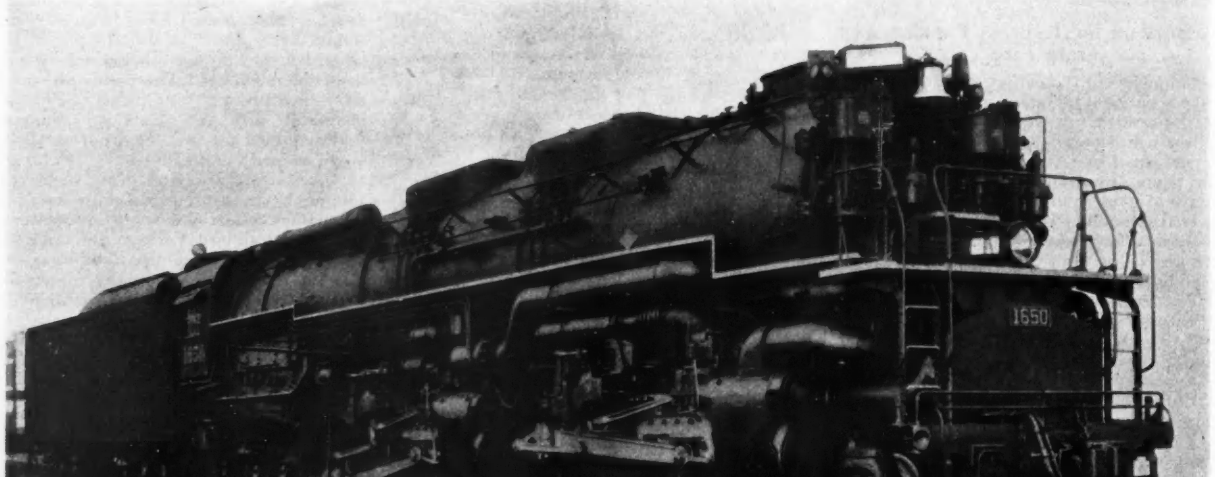
Cylinders, number, diameter and stroke	Four, 22½in by 33in
Valves, type and diameter	Piston, 12in
Wheels :	
Driving, diameter	67in
Leading truck, diameter	36in
Rear truck, diameter, front and intermediate	36in
Rear truck, diameter, back	43in
Wheel base :	
Driving	34ft 8in
Engines	62ft 6in
Engine and tender	112ft 11in
Dimensions :	
Height to top of chimney	16ft 5½in
Height to boiler centre	10ft 10in
Width, cylinder centres	90in
Boiler :	
Steam pressure	260 lb per sq in
Diameter first ring, inside	98in
Diameter largest outside	109in
Combustion chamber length	118in
Thermic siphons	Three
Heating surfaces :	
Firebox and combustion chamber	600 square feet
Siphons	162 square feet
Firebox, total	762 square feet
Tubes and flues	6478 feet
Evaporation, total	7240 square feet
Superheater	3186 square feet
Combined	10,428 square feet
Grate area	135·2 square feet
Tender :	
Water capacity	25,000 U.S. galls.
Coal	25 tons (2000 lb)
Trucks	6 and 6-wheeled
Rated tractive force at 85 per cent	110,200 lb
Weight proportions :	
Weight on drivers/weight of engine	65·1 per cent
Weight on drivers/tractive force	4·27 per cent
Boiler proportions :	
Firebox heating surface, per cent combustion heat surface	7·3 per cent
Superheater heating surface, combustion	30·6 per cent
Firebox heating surface/grate area	5·63
Gas area/grate area	8·86 per cent
Evaporative heating surface/grate area	53·5
Combustion heating surface/grate area	77·1

NOTE.—The last fifteen locomotives of this class, "H8" and type 2–6–6–6, have slightly modified heating surfaces in the tubes, flues and superheaters as already noted.

The following are particulars of the maximum static rail loadings and the dynamic rail loadings at diameter speed :—

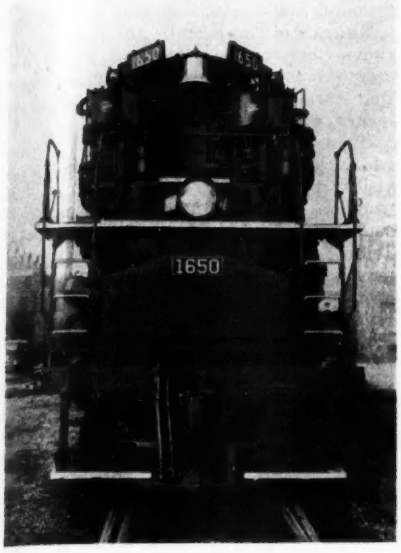
Factor of adhesion	4·27
Average weight per coupled axle (static weight)	78,500 lb
Maximum overbalance	309 lb
Speed, miles per hour (dia. speed)	67
Dynamic loading (dynamic augment)	16,380 lb
Total maximum rail loading	94,880 lb
Dynamic loading, per cent of static loading	20·8

The above particulars are based on the assumption that the maximum axle loading



C. AND O. CLASS "H 8" LOCOMOTIVE No. 1650

is equal to the average weight per coupled axle and that the maximum speed is 67 m.p.h., that is, diameter speed, the engines having 67in drivers. In practice the dynamic loading would be much less than the value



FRONT END OF LOCOMOTIVE

given, because usual maximum operating speeds are about 40 to 45 m.p.h., while 60 m.p.h., is the maximum intended speed.

THE BOILER AND SUPERHEATER

The radially stayed boiler is 45ft 11in long, and has a barrel section made up of three courses. The first course next to the smokebox is slightly tapered with an inside diameter at the front of 98in, and the remaining courses are cylindrical, that next to the firebox having an outside diameter of 109in. Flexible stay bolts are extensively used for the combustion chamber and in the breaking zones of the firebox, which has three siphons. At the sides, front and back, the width of the foundation ring is 7in. The inner firebox and the combustion chamber are of welded construction, except the inside door plate seams, which are riveted.

The total heating surface is 9716 square feet in the later design compared with 10,426 square feet for the earlier locomotive.

Particulars of the heating surfaces for the earlier engines and for the last fifteen constructed are as below :—

Locomotives, 1941–1944

Tubes	48, 2¼in diameter, 23ft long
Flues	278, 3½in diameter, 23ft long
Heating surfaces :	
Tubes and flues	6478 square feet
Firebox and combustion chamber	600 square feet
Siphons	162 square feet
Evaporative	7240 square feet
Superheater	3186 square feet

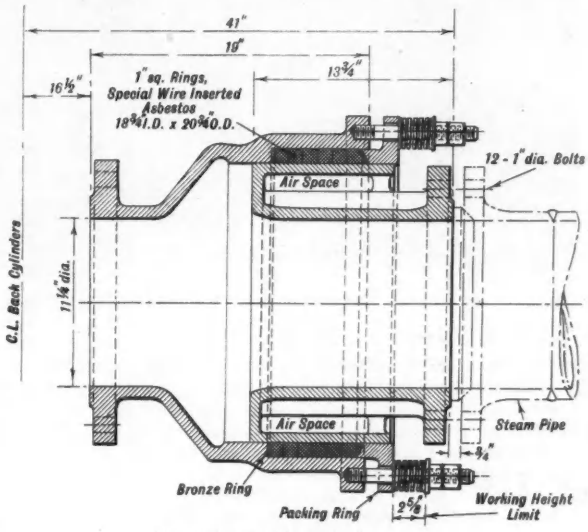
Locomotives, 1948–1949

Tubes	58, 2¼in diameter, 23ft long
Flues	219, 4in diameter, 23ft long
Heating surfaces :	
Tubes and flues	6032 square feet
Firebox and combustion chamber	600 square feet
Siphons	162 square feet
Evaporative	6794 square feet
Superheater	2922 square feet

The area of the firegrate common to all engines is 135·2 square feet, and the air openings through the grate is approximately 25 per cent. Firing is by means of a standard type M B stoker. For feed-water supply there is a Worthington feed heater having a capacity of 14,400 U.S. gallons per hour and an injector of 14,500 gallons capacity.

THE STEAM SUPPLY SYSTEM AND DISTRIBUTION

The main steam supply for the engines is taken by an internal pipe from the dome to the superheater header from whence it flows through the elements and the multiple throttle valve to the cylinders. From the throttle the steam flows through branch pipes in the smokebox which connect with outside steam pipes of 11½in inside diameter, one on each side of the boiler supplying steam to the rear pair of cylinders and by means of a Y pipe to a central receiver pipe leading to a further Y piece by which the steam is divided between the front engine cylinders. The central steam pipe is carried on the framing of the leading engine and as the rear engine is fitted with a ball joint to provide the necessary articulation. There are three expansion joints in the steam piping, one in each length of pipe from the smokebox to the rear engine cylinders, and one in the central steam pipe taking the steam to the front pair of cylinders. These expansion joints are of a novel and interesting design, the special feature being that the surfaces bearing against the gland packing are separated by an open air space from the steam containing walls of the joint. The drawing of this joint reproduced on this page shows the arrangement, from which it will be seen that the gland ring is spring loaded to maintain steam tightness combined with the least resistance against longitudinal movement.



AIR COOLED EXPANSION JOINT

The exhaust steam from the cylinders of the rear engine passes to the rear exhaust pipe in the smokebox by way of two pipes, one on each side, and the exhaust from the front engine passes through a Y piece uniting the two exhausts, which then passes to the front exhaust pipe in the smokebox. The two exhaust nozzles are 7in diameter, and have ½in square cross bridges. They exhaust into a double chimney. The superheated steam is distributed in the cylinders by 12in valves actuated by the Baker gear. They have a full gear travel of 8in and 1 7/16in steam lap, 3/16in lead and are line and line at the exhaust edges. Power reversing gear is fitted.

ENGINE FRAMES AND RUNNING GEAR

The front and rear engine units have cast steel bed frames embracing the cylinders with the rear covers, cradle, brake hanger brackets, drawbar pockets, guide bar supports, and brackets for other details of equipment. The front and rear units are connected by an articulation joint comprising a tongue cast on the joint frames which fits into a pocket cast integrally with the rear engine frames and united by a hinge pin mechanically lubricated. A single boiler bearing of the sliding pattern, incorporating a coil spring centring arrangement, transfers the weight of the boiler to the leading engine.

All four corners of the firebox have mechanically lubricated sliding shoes in oil-tight casings fixed to the rear framing. In addition, lateral bearers are fitted at the rear of the firebox.

The coupled wheels, of the normal spoked pattern, with the spokes reinforced by ribbing, are mounted on hollow medium carbon steel axles. Timken double roller bearings in double housings carry the driving axles. The axlebox guides are of cast steel with phosphor bronze liners. The leading coupled wheels in each group are fitted with the "Alco" cushioning device.

At the leading end the engine runs on a single axle truck having 36in diameter wheels and Timken roller bearings.

The six-wheeled trailing truck has four 36in wheels and a trailing pair of 43in diameter. These wheels have 36in centres and separate tyres. The other truck wheels are of solid rolled pattern without separate tyres. The spring rigging and the overhung laminated bearing springs are of conventional design, and the spring gear for each power unit is equalised throughout.

The welded cab and the footplate are carried by cast steel brackets. These units are mounted on the main framing and are fitted with sliding shoes at the rear end of the cab to provide for expansion. At the front of the cab the brackets are supported by the rear bearer shoes which also support the rear end of the firebox. This arrangement permits the cab to move with the boiler.

CYLINDERS AND MOTION

The four cylinders are 22½in diameter, and the stroke is 33in; they have cast iron bushings, as have also the piston valve liners. The crossheads are underhung with tin-lined multiple bearing surfaces. Medium carbon steel forgings are used for the connecting and coupling rods. Floating bushes fitted in the rods at the main crankpins are of iron at the connecting rod ends and of bronze at the coupling rod connections. The reciprocating masses for each cylinder weigh 2152 lb, of which 41·7 per cent is balanced. The overbalance is distributed in the following manner :—leading wheels 285 lb, intermediate 304 lb and the trailing wheels, the main drivers 309 lb. The Baker valve gear is controlled by an "Alco" reverse gear carried on the rear engine frames. The motion for each of the power units is identical. One of the illustrations shows the right hand motion for the rear engine and the "Alco" power reversing gear which operates the valve gears for both the

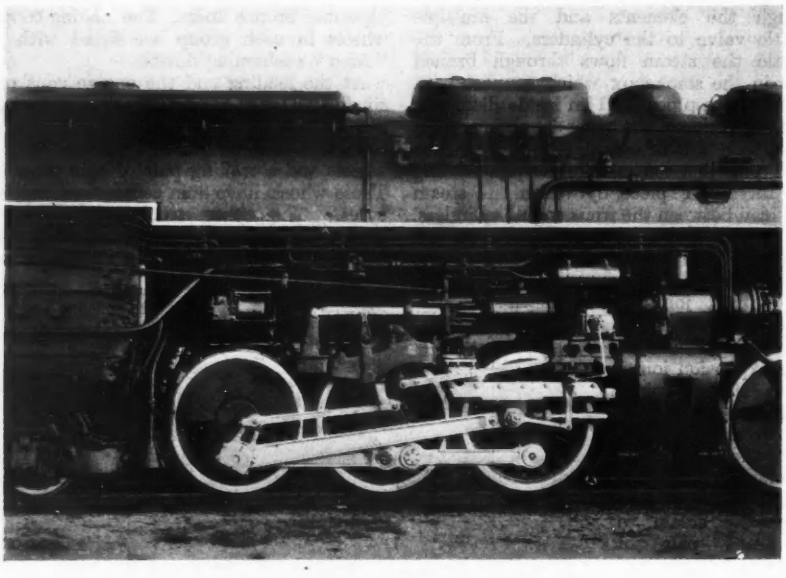
leading and rear engines, and also the arrangement of one of the mechanical lubricators operated by a connection with the combining lever of the Baker valve gear.

One of the features of these engines is the very extensive mechanical lubricating system provided. There are two mechanical lubricators fitted on the left hand side of the engine furnishing oil to the valve spindle crosshead guides, engine truck centre pin and axlebox guides, all main driving axlebox guides, articulation hinge pin, boiler and firebox bearing shoes, radial buffer and the trailing truck axlebox guides and hub faces. A further two lubricators on the right side of the engine supply oil to the steam pipe joints, cylinders, crosshead guides, exhaust pipe joints, feed water heater pumps, air compressors, and to the stoker engine.

Soft grease fittings are applied to a large number of parts, including brake hanger pins, lateral cushioning devices for the leading drivers and the valve gear reversing gear connections.

Fittings for hard grease are applied to the main crankpins, crosshead pins, eccentric rods, and the connecting and coupling rods.

The air brake applies blocks to the coupled wheels and to the wheels of the engine trailer and the six-wheeled and eight-wheeled tender trucks, the latter being braked to 70 per cent of the light weight.



CYLINDERS AND MOTION AT REAR END

(To be continued)

Engineering in the Festival of Britain

By BRIGADIER J. L. P. MACNAIR*

SIR WILLIAM L. BRAGG in a recent lecture at the Royal Institution on "Science and the Adventure of Living," expressed the view that we are standing on the threshold of a new age—an age that is characterised by a sudden acceleration in the *tempo* of life. Up till the first few decades of the nineteenth century the maximum speed of movement for thousands of years had remained at about 10 miles per hour. The Industrial Revolution saw this figure increased to the region of 60. But now, after only about 100 years more, the rate has suddenly been multiplied by ten; while rockets, telecommunications, calculating machines, and scientific and literary digests all contribute to what amounts to a totally new medium of existence. The contemplation of this immense increase in the technique of speed is a challenge to mankind. What use shall we make of it? For there is one factor in the cosmic scheme which appears to remain relatively static, namely, the power and speed of thought. However great the adventitious aids that the development of civilisation evolves for its own advancement, it is on the practice of men's minds that the outcome surely depends.

* Science Staff, Festival of Britain

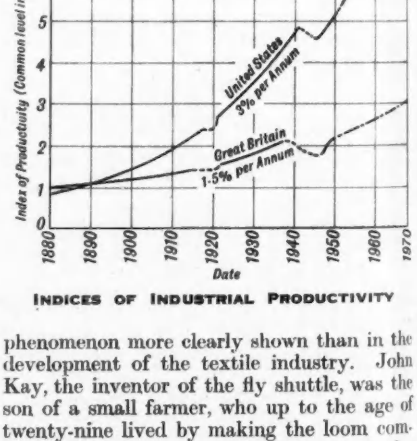
It is perhaps something more than a coincidence that the Festival of Britain occurs at a time when we are facing this uncertain but exciting dawn. It is appropriate that we should pause for a moment—of enjoyment and contemplation—to take stock of the years that are past and the achievements of to-day; to approach the ever more rapidly moving future with as clear a knowledge as we can obtain of whither we are going. No one branch of knowledge has contributed more to the changing matrix of our life than engineering in its various forms: civil, mechanical and electrical. It is possible, indeed, to argue without undue exaggeration that it is primarily the work of engineers rather than of anyone else which has brought about the great changes, social economic and political, that have marked out the last two centuries. It is appropriate, then, that the work of engineers should be and will be widely acknowledged during the Festival of Britain.

The South Bank Exhibition

Standing on the central fairway of the South Bank Exhibition in London, the interested visitor will see all around him buildings—of which the great "Dome of Discovery" is an impressive example—all of which provide striking evidence of recent advances in the science and art of structural engineering. Within these buildings the work of the engineer will be traced for the visitor in ever-increasing importance as he follows the main theme of the Exhibition. Agricultural machinery in the "Country Pavilion," mining machinery in "Minerals of the Island," the machines that convert our coal to gas and electricity in the great power stations, the distribution schemes that carry the power to our factories and homes, will all follow in their logical order.

In the "Power and Production" pavilion, where the latter part of this story is told, the visitor will see many other aspects of the work of the factories, without which we could barely feed a half of our population. Tribute will be paid to a few outstanding personalities who contributed to the amazing change in our way of life that set in during the eighteenth century. The simple advances in technique, such as that exemplified by Wilkinson's first boring machine, which helped to enable Watt's engines to achieve an efficiency beyond the dreams of Savery, are to be balanced against far-reaching reforms like those of Whitworth in the standardisation of screws. It will be brought out how we owe to that same Whitworth one of those illuminating flashes of genius that give birth to a simple yet epoch-making advance. Before his day no one had ever produced a true flat surface. He realised, it will be recalled, that, though two such surfaces cannot be tested one against the other without reproducing complementary errors, when a third is introduced the errors cannot be mirrored in all. His master tables were produced by manual abrasion of a cast iron surface and laid a true foundation for progress in more senses than one.

A curious feature of the early period referred to is the influence and importance of a peculiarly British product, namely, the amateur engineer. In the present days of great professional institutions, when employers of technical skill very naturally seek safety behind a string of qualifying letters, it is easy to forget how much of our present dominant position in the engineering world is due to the natural inventive genius of our race, which found expression in the most unexpected individuals. In no field was this phenomenon more clearly shown than in the development of the textile industry. John Kay, the inventor of the fly shuttle, was the son of a small farmer, who up to the age of twenty-nine lived by making the loom component known as the reed. Crompton, also the son of a small farmer, made a spinning machine of his own, and earned his living by spinning and weaving in the house which his parents occupied as caretakers, and by playing the violin in the Bolton theatre orchestra.



INDICES OF INDUSTRIAL PRODUCTIVITY

He made no attempt to patent his innovation of the "mule," and died in poverty. William Lee, the inventor of a very ingenious machine for knitting stockings, was a clergyman. Even more remarkable was another clergyman, Edmund Cartwright, who, it will be remembered, invented a power loom, having, in his own words, "never before turned my thoughts to anything mechanical, either in theory or practice." In the Exhibition the work of such men will be contrasted with the modern developments of which their devices were the seed.

British genius has indeed often been best displayed in improvisation. But we are all victims of the age we live in. We are sometimes slow to learn, but experience is a hard master, and the work begun by individuals has now very largely—due to advancing techniques and increasing complexity—to be carried out by organised teams to a planned programme. A glimpse of what this means will be seen in the gallery, where display panels and exhibits illustrating the work of management, research, design, and inspection preside symbolically over the machines on the main floor below.

It might, perhaps, at this point, be salutary to mention one of the many aspects of engineering which has of necessity been omitted from the Exhibition. Queries will undoubtedly arise from enthusiasts in this or that branch of knowledge about matters which to them are of outstanding importance, but which from sheer spacial restriction and the limitations of our resources have undeservedly suffered relegation in the process of selection. One such subject which might have received notice in the Management section is that dealt with by Sir Ewart Smith in a paper given to the Education Section of the British Association on September 4, 1950. The way in which the indices of industrial productivity in Great Britain and the United States have changed since 1880, when we led the world in this as well as other respects, is shown opposite. But in the Festival this country is celebrating its achievements during the last century and more, and to have fallen so far behind America in productivity is not a matter for congratulation! An article such as this is clearly no place in which to discuss Sir Ewart's proposed remedies, except to remember that they are the direct concern of the engineer. We may look on our past and present efforts with pride, but not with complacency.

Goods that are made in factories must be carried to the people who want to use them. And so the visitor will leave the great shop window of the "Power and Production" pavilion to see, first, "Sea and Ships," and to find there the names of Ackroyd Stuart, the father of the diesel engine, and Parsons, the father of the steam turbine, honoured by exhibits showing how great a debt we owe to them. Nor does the turbine story end on steam. The genius of Whittle and the patient work of the metallurgists which, jointly, have brought the gas turbine from aircraft into the purview of the marine engineer, are also honoured.

The development of the internal combustion engine, leading up to the construction of gas turbines and jet engines, will best be seen in the next pavilion, which is devoted to "Transport," whether by sea, air, road or rail, and with the electronic aids that link and serve them all. Here will be displayed the work of engineers of all kinds—civil, in building harbours and docks, great and small, roads, railways, and airfields; mechanical, in the designing and operation of mechanisms; and electrical, in the transmission of power, and messages and signals all over the world.

"I have no desire for fame," wrote Watt in introducing his parallel link motion, "but I am more proud of this invention than of any other that I have made." In a section dealing with the Mechanics of Machines, in this "Transport Pavilion," locomotive engineers will be able to trace with pleasure the transition from early devices to some of the more complicated valve gears on modern locomotives. Other technical subjects dealt with in this little "Fundamental Corner" will be friction and lubrication (in working out the theory of which British scientists have been in the forefront), gearing, servo-mechanisms, and the like.

For those with an interest in civil engineering, the work of tunnelling, road-making, and bridge building will all be found exemplified in the same pavilion. Exhibits illustrating the new road to South Wales will introduce them to the great suspension bridge across the Severn, in the design of which research workers at the N.P.L. have played an important part. For the experience gained from the Tacoma bridge disaster in America and so readily made available to us by our American friends, has been put to good use in wind tunnel experiments at the N.P.L. to study the aerodynamic characteristics of such bridges and so place their design on a satisfactory theoretical footing.

The work of the civil engineer will be found acknowledged again under the "Dome of Discovery," where the development and control of land and water resources in various parts of the world is illustrated. One great project within our own shores whose domestic appeal gives it special importance is the Great Ouse fen drainage scheme. The problem facing the engineer here is well brought out by the iron pillar, 10ft high, buried to its top in the Fens in 1848 and now completely exposed. Drain the peat lands and they shrink! As they shrink the water to be pumped off them has to be lifted to increasing heights while the effects of floods threatens to become more and more devastating. The job of draining the Fens has been going on for three hundred years or more, and so long as men live there, there will be work there for civil engineers to do.

Other Exhibitions

In connection with the Festival, the displays on the South Bank will be epitomised in the Festival ship "Campania," where similar stories will be told, of course, on a smaller scale. This ship will, in the course of the Summer, visit ten major ports round the British Isles, staying about a fortnight in each.

At the Kelvin Hall, Glasgow, Scotland will provide its own national exhibition. Here engineering occupies the full stage. The visitor will be able to pass through halls in which industrial power will be the motif, heavy engineering the ground. Power is derived from two basic sources, coal and water. The visitor will be offered two routes to follow: one into the depths of the earth to see the latest machines evolved to help the miner to dig the coal needed to feed the machines to keep our land alive; the other through a glass tunnel completely enveloped in falling water, to study the achievements of the civil engineer in controlling and directing this natural force so abundantly available in the nearby Highlands. Both routes will lead through sections depicting different aspects of engineering, and at their meeting-place they will lead on to the story of shipbuilding and railways. A final hall will afford a suitably dramatic glimpse at the possibilities of the future.

To ensure that in all the exhibitions, even though their appeal will be as much "popular" as technical, the subject of engineering will be presented completely and accurately, advisory panels, drawn from leading members of the great engineering institutions, were formed early in 1949, and their members have given constant and ungrudging assistance to the organisers throughout, not only in their individual capacity as experts in various fields, but in advising where further professional help was to be sought in particular matters.

A Pressure-Filled Breaking Piece for Load Limitation

By W. H. BAILEY, B.Sc.(Eng.)

A PRESSURE-FILLED breaking piece, which can limit far more accurately than conventional cast iron breakers the maximum loads which can be applied to the roll necks of rolling mills has been constructed by the Roll Design Section of the British Iron and Steel Research Association. It was designed primarily for rolling mills, but there is no reason why the new breaker should not be used in other machines, such as power presses and shears, where it is important to limit the maximum load,

The maximum error when this pressure-filled breaker is used is plus or minus 2 per cent, whereas cast iron breakers may vary from the mean by plus or minus 10 per cent, using sound castings of identical dimensions and from the same ladle. For different casts of the same nominal composition the variation may be as much as plus or minus 20 per cent. Cast iron breakers have therefore to be dimensioned so that the strongest sample likely to be received will not be stronger than the parts they are intended to protect, and they will break prematurely with increasing frequency as the working load is raised above the carrying capacity of the weakest sample.

Besides greatly reducing this uncertainty, use of the pressure-filled breaking piece enables the breaking load to be adjusted readily to suit the condition of the rolls in use.

Fig. 1 is an isometric view of the breaker, which has been made and tested in a 50-ton compression testing machine. Its construction and operation are as follows:—

The cavity *A* in the base *B* is closed by the soft copper diaphragm *C*, about five thousandths of an inch thick. A fluid-tight joint between the diaphragm and the base is made by compression of a copper ring *D* by a retaining ring *E*. Resting upon the copper diaphragm is a punch *F*, an upward movement of which is prevented by a retaining ring secured to the base by a ring of bolts. The inwardly projecting lip at the mouth of the cavity and the outwardly projecting lip of the punch have hardened cutting edges *G* and *H*, respectively. A spherically seated pad *J* receives the thrust of the mill screw and the base rests upon

the chock. The base, punch and retaining ring are made of oil-hardened steel, having the approximate composition C 0·6 per cent, MN 0·3 per cent, Si 1·0 per cent, Cr 1·0 per cent. Before inserting in the mill, the pressure in the cavity is raised by pumping in gas with or without liquid through a non-return valve *K* until it is such as will support the difference between the load at which the breaker is intended to operate and the load required to shear the diaphragm, any excess of the fluid thrust over the roll force being carried by the retaining ring. It will be seen that if the thrust from the

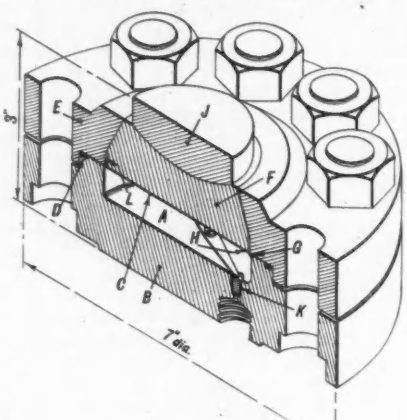


FIG. 1—ISOMETRIC SECTION THROUGH BREAKING PIECE

screw should exceed the fluid thrust by more than the shearing force of the diaphragm, shearing will take place. This will enable the fluid to pass into the clearance space *L* and through the space which will have opened between the punch and the retaining ring as the former descends relative to the latter. The chock will then be free to rise and relieve the force on the roll neck. The diaphragm is not intended to contribute to the load-carrying capacity but only to prevent the escape of fluid until operation of the breaker takes place.

The sealing ring is made by bending ⅛in diameter soft copper wire round the spigot of the base and cutting it so that the ends abut squarely when it is tapped into the recess in the retaining ring. After

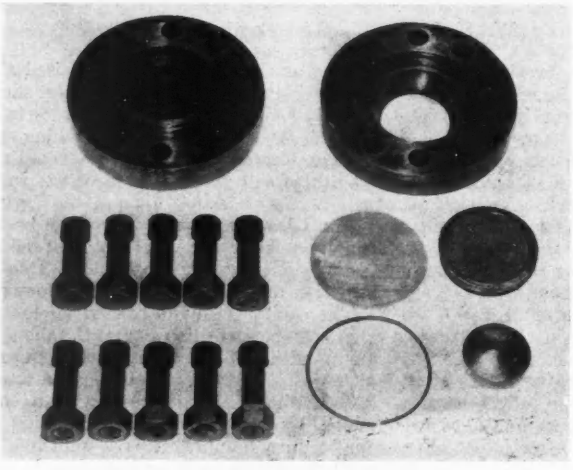


FIG. 2—PARTS OF BREAKING PIECE

assembly, the retaining ring is pressed down on to the base with a force of about 50 tons in a compression-testing machine or suitable hydraulic press, which reduces the vertical diameter of the wire from 0·125in to 0·093in, and it is the resulting lateral spread which provides the sealing pressure.

The diameter of the punch over the cutting

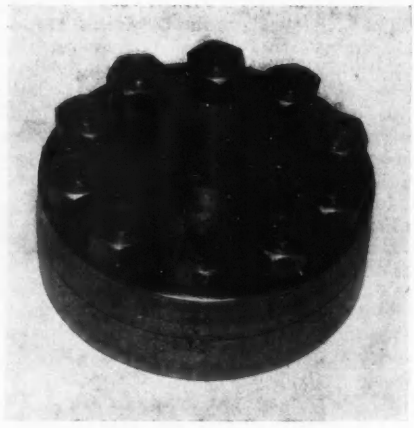


FIG. 3—ASSEMBLED BREAKING PIECE

edge is 3⅜in, giving a face area of 10·6 square inches and the travel of the punch is about $\frac{9}{16}$in. The overall diameter is

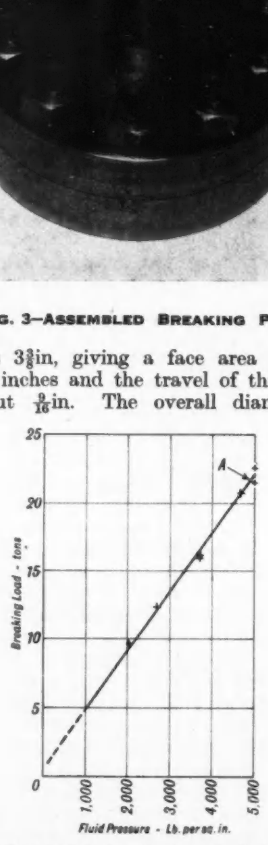


FIG. 4—RELATIONSHIP BETWEEN BREAKING LOAD AND FLUID PRESSURE

7in and the depth 3½in. Figs. 2 and 3 are photographs of the breaking piece dismantled and assembled, respectively.

The non-return valve at present in use consists of a small brass plug, tapered at an included angle of 10 degrees, seating in a polythene sleeve in a hole reamed to the same taper in the base. This valve has proved entirely fluid-tight but a new sleeve is required after two or three chargings to maximum pressure.

It is essential that there be some gas present in the cavity to allow the diaphragm to move down while being sheared. The air initially present is insufficient (at 5000 lb per square inch it would be compressed, in the present example, to a layer only about 2 thousandths of an inch thick) and charging is commenced, therefore, by connecting the breaker to a full or nearly full gas bottle, which provides an initial pressure of the order of 1500 to 2000 lb per square inch. In the tests nitrogen has been used for convenience.

Connection is then transferred from the nitrogen bottle to a high-pressure oil pump, fitted with means of indicating the pressure, such as a Bourden gauge or a ground and lapped plunger loaded with dead weights, and oil is injected to displace gas and raise the pressure to the figure required. Oil rather than additional gas is used because of the greater ease with which it can be pumped.

Results of the tests in the compression testing machine are shown in Fig. 4. It will be seen that the maximum departure of a load from the mean line is 1·6 per cent and that there was no significant loss of pressure when standing charged for a week (Point *A*). In these tests the temperature at breaking was the same as at charging; each degree difference between them would cause about 0·3 per cent change in the breaking load.

Fig. 5 shows an alternative design in which a screwed collar is used to replace the bolts and nuts and it is estimated that

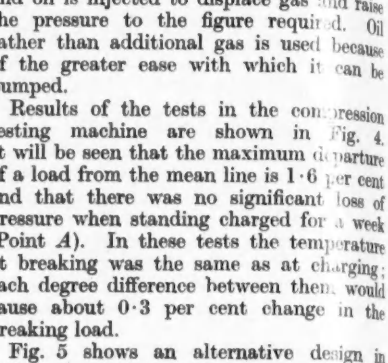


FIG. 5 ALTERNATIVE DESIGN OF BREAKING PIECE

it would be capable of a safe load capacity of 50 tons for a diameter and height of 6½in and 3in, respectively, as against 25 tons for the design tested, in which the diameter was 7in and the height 3½in.

Patent applications have been filed in this country and in the U.S.A. (Nos. 28018/48 and 124,184, respectively), for the breaker described in this article, which is published with the permission of the Rolling Committee of the British Iron and Steel Research Association.

A Dutch Machine Tool Exhibition

WE have received particulars of an exhibition of machine tools and woodworking machines, which is to be held in Rotterdam, from May 30th to June 9th next. This exhibition is being organised by Stichting Technisch Centrum, a body formed by four Dutch importers' associations, particularly concerned with metal working machinery, tools, steel and woodworking machines, for promoting technical exhibitions covering their particular fields.

The promoters state that the exhibition is being organised because it was not considered that the Utrecht Fair satisfied the needs of the associations in attracting technical visitors interested in machine tools and allied equipment. The independent exhibition of machine tools will be the first of its kind to be held in the Netherlands and practically all the leading Dutch trading companies interested in machine tools and tools will be represented.

The exhibition will be held in the Ahoy Halls, which were built for the Rotterdam Port exhibition in 1950. It will cover an area of some 8500 square yards and sixty-six firms will exhibit machines and equipment imported from all parts of Europe and the United States. The organisers have invited foreign manufacturers whose Dutch agents will be exhibiting to send technical experts to demonstrate their plant for Dutch buyers.

The exhibition will be known as Techni-Show '51, and the offices of the organisers are at Eendrachtsweg 64, Rotterdam.

The National Bureau of Standards Eastern Automatic Computer

"SEAC," the National Bureau of Standards Eastern Automatic Computer, has now been in operation at the Bureau in Washington, D.C., for several months. It is considered to be the fastest general-purpose, automatically-sequenced electronic computer in use at present. It was developed and constructed in a period of twenty months by the staff of the National Bureau of Standards under the sponsorship of the U.S. Department of the Air Force to provide a high-speed computing service for the Scientific Computation of Optimum Programmes (SCOOP) project, a pioneering effort in the application of scientific principles to the large-scale problems of military management and administration. The computer will also be available for solving other important problems of general scientific and engineering interest.

The machine automatically performs all of the logical and arithmetical operations required to solve a particular problem when it is supplied with coded instructions and numerical data. Its high speed permits the use of many simple steps that can be combined into a complex and powerful sequence for the solution of difficult problems. This makes it possible to solve important mathematical, computational and statistical problems which would otherwise be impossible of solution in any reasonable period of time, or which would be prohibitive in cost if attempted by conventional methods.

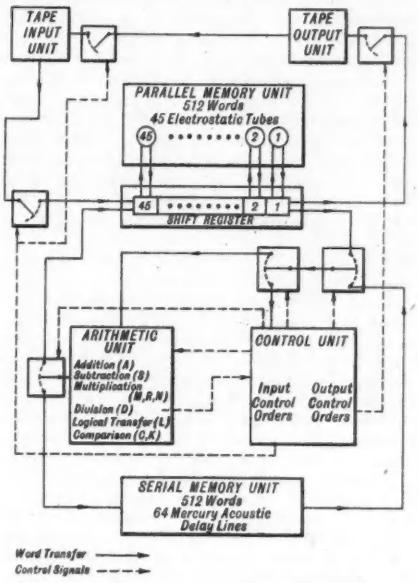
All operations are carried on in a binary number system, the presence of a pulse indicating "1" and the absence of a pulse indicating "0." A sequence of forty-five binary digits is known as a "word" and may convey to the machine operational instructions as well as numerical data. The binary system was chosen because it is simple and rapid and particularly suited to electronic machines. Conversion from the decimal system, in which the problems are prepared, is done automatically and requires only about 0·1 second per number.

The high computing speed of the machine is largely the result of two design features: its rapid pulse rate of 1 Mc/s and its large memory of 512 words capacity. They make it possible for SEAC to add or subtract pairs of eleven-digit numbers 1100 times a second and multiply or divide them 330 times a second. These rates include the time it takes for the machine to search its memory for the numbers, operate upon them, and return the result to the memory. An arithmetical operation of addition or subtraction alone is completed in 50 microseconds; multiplication or division is completed in 2500 microseconds.

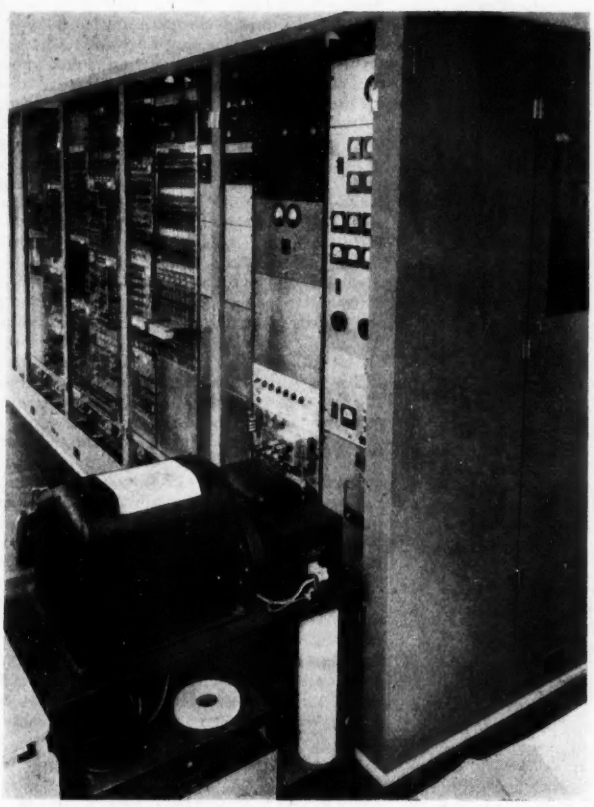
The computing functions are carried out in four main sections: an input-output unit, a memory unit, a control unit and an arithmetic unit. The input-output unit is the link between the machine and its operators. Here numbers and instructions are fed in and answers are printed out. The memory unit stores numbers and instructions, as well as partial answers, until they are needed. The control unit constantly selects the paths along which information must travel, searching the memory for numbers to send to the arithmetic unit, returning answers to the memory and finally directing the memory to deliver the answers to the operator via the input-output unit. The arithmetic unit carries out the actual computations which the control unit directs it to perform. Switch symbols used in the accompanying block diagram indicate electronic operations performed automatically under the direction of the control unit of the machine, the switching times being in the region of 1 microsecond.

Engineering Design

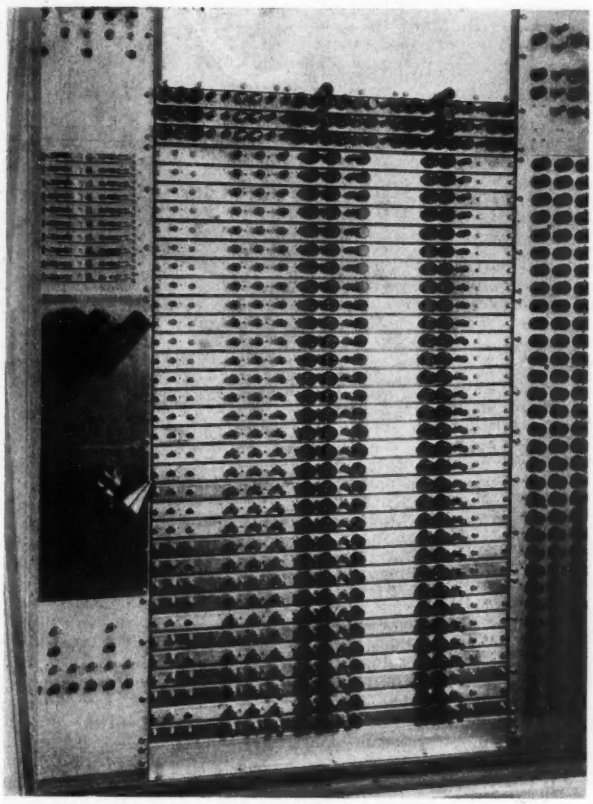
In the development of SEAC emphasis was placed on designing circuits especially for computer use rather than adopting the standard techniques of television and radar circuitry. All computing and switching is performed by interconnected germanium crystal diodes rather than by electron valves. Valves are employed only for power amplification. The entire computer, together with its memory units, contains a total of 15,500 germanium diodes and 1050 electron valves. A uniform valve and transformer combination, consisting of a single valve



COMPUTER OVERALL BLOCK DIAGRAM



COMPUTER UNIT RACKS AND CONTROL TABLE



SERIAL MEMORY UNIT

coupled to the load through an appropriate transformer, is used throughout the machine to simplify both design and maintenance. The transformer method provides effective high-frequency coupling with a minimum of cross-talk between circuits. This kind of circuit design and the method of construction and assembly make it relatively easy to add units to the machine, and the present version of SEAC is considered to form a nucleus for a larger and more versatile computer.

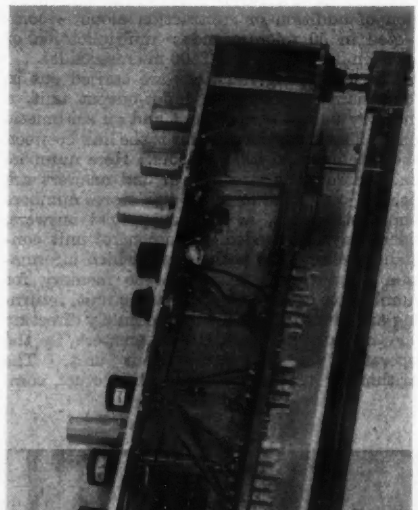
Because SEAC was needed for use as quickly as possible, its design was kept simple, and the equipment which had to be built initially was held to a minimum. The computer was designed to operate as a serial machine because this mode of operation requires less equipment than the parallel method; this does not, however, mean a decrease in functional effectiveness. The list of basic operations or instructions was abridged for the same reasons, but provision was made for later expansion.

SEAC has seven basic orders, chosen after a study which established their convenience for solving the most elaborate problems the machine is expected to handle. The orders are addition, subtraction, multiplication, division, comparison, logical transfer, and input-output control. The comparison order allows two numbers to be compared to determine which is larger. This feature gives the machine a degree of choice. The result of a comparison thus dictates which of two alternative operational sequences the machine is to perform next. The logical transfer order makes it possible for the machine to alter a portion of an instruction it has previously received. Thus, the computer can modify its instructions, ascertain if it has made errors, determine when it has computed results to predetermined accuracy, and refrain from printing out incorrect answers.

The present input-output unit of the machine employs a manual keyboard for direct input and a teletype printer for direct output, using a hexadecimal notation (base 16) to represent both numbers and instructions. Indirect operation is accomplished through the use of punched paper tape. Input and output by means of paper tape proceeds at the rate of thirty words per minute. If magnetic wire or tape is substituted the rate can be increased to 10,000 words per minute. The design allows for the later replacement of the paper tape system by an entirely automatic high-speed magnetic wire system. An initial model of a magnetic wire input-output unit which provides a single information channel has already been completed and is currently being integrated into the machine. SEAC is flexible enough to accommodate a wide range of single or multiple-channel input-output systems, so that future developments in magnetic tapes or drums can be directly incorporated if this is desirable.

The memory unit employed at present is a serial one, whose principal components are sixty-four acoustic delay lines and associated electronic equipment. One of the illustrations on page 215 shows one side of the serial memory unit, with thirty-two recirculation amplifiers, each employing two 6AK5 and three 6AN5 miniature electronic valves mounted in front of their associated mercury acoustic delay lines. The three distinctive units at the top of the central array are selection generators, which, when signalled by the control unit, pick out the proper acoustic channel and send driving signals to the access circuits at right. Indicator lights for the temperature control system appear at the extreme upper left. The acoustic delay lines are glass tubes, ½in diameter by 24in long, filled with mercury which is in contact with two quartz crystals, one at each end. The electronic components reshape and amplify the pulses in the delay lines, and energise the germanium diode switches in this part of the system. The capacity of this memory unit is 512 words; that is, eight words in each of the sixty-four acoustic delay lines. Each word is stored as a sequence of sound waves travelling in mercury. The mercury lines are attached to aluminium plates which are maintained at 50 deg. Cent. within $\pm\frac{1}{4}$ deg. The waves have a frequency of 8 Mc/s and are generated by the quartz crystal at one end of the mercury-filled tube and received by the crystal at the other end. The electrical signal from this crystal goes to a special electronic amplifier, which returns the pulse sequence, at its original strength, to the first crystal. In this way a word is recirculated until it is replaced by other information from the computer. Because of the serial nature of the storage, the average access time to a word in the memory is 168 microseconds. The addition of a parallel memory system of forty-five electrostatic tubes storing an additional 512 or 1024 words with an access time of only 12 microseconds is currently in progress.

SEAC is housed in two consoles; the acoustic memory unit is in one, the rest of the computer, including space for the parallel memory, in the other. The memory cabinet is 60in in width, 31in in depth and 84in in height. The computer proper is enclosed in a cabinet 15ft long, 5ft in depth, and 8ft in height. Inside this



INDIVIDUAL RECIRCULATION AMPLIFIER AND ACOUSTIC DELAY LINE

cabinet are eighteen racks, each 19in in width and 72in in height, on which are mounted chassis bearing the individual components.

The computer is not a "giant brain"; the preparation of an instruction programme to be solved on SEAC requires a great deal of skilled work by specially trained mathematicians. Before the machine can attack a problem it must be given exact instructions governing every step in the solution. Thus, each machine is only as proficient as its operators. It does not replace the scientist; it merely takes the drudgery out of his work, freeing him to pursue more advanced problems. SEAC possesses a useful time-saving feature in connection with this very problem. Once the programme for a particular kind of problem has been coded, it can be used over and over again with different sets of numerical data. The change-over from one type of problem to another is accomplished by sending in a new set of instructions through the input-output unit. No rewiring or switch setting is required. Instructions previously read into the machine may also be altered without complete erasure. This simplifies the preparation of problems since less complete instructions are needed at the outset.

SEAC has already been used to solve important problems in optics and in thermodynamics, as well as several purely mathematical problems of general interest, which were solved initially for the purpose of testing the machine. In one of the latter the machine was directed to compute the factors of any given number up to 100 billion. In a relatively short time it determined, for example, that the number 99,999,999,977 has no factors and is therefore a prime number. In order to do this, SEAC divided the number by 80,000 different trial divisors, which it systematically generated within itself. This problem, which represents two months' work for a man operating a desk calculator eight hours a day, required thirty minutes for its solution on the computer.

SOLUTION OF A HEAT FLOW PROBLEM

A typical example of the operation of the computer was its solution of the problem of the flow of heat through a chemically reactive material which is represented by the partial differential equation $\theta_t = \theta_{xx} + e^{-1/\theta}$. The computation laboratory of the National Bureau of Standards had for several years been interested in solving this equation for nine sets of initial conditions, defined by the expressions $\theta(x,0) = \theta_0$ and $\theta(0,t) \| \theta_1$. Because the problem is so complex, the solutions for only four sets of initial conditions were worked out by the use of punched card calculating equipment. As each solution is progressively more difficult, it did not seem practicable to continue with the remaining five sets of conditions. The simplest of the four solutions required nineteen days, and this time would have been more than doubled if several simplifications had not been applied.

A recomputation of the first solution was one of SEAC's earliest significant problems. The computation was completed in forty-six minutes, including sixteen minutes to type the results. All of the simplifications which had been applied in the earlier solution were omitted when the problem was coded for the machine.

In the half hour of actual computing, SEAC carried out the following operations. Starting with the temperature values given by the initial conditions, it derived by repetitive application of a computational formula the temperature values at successive intervals of time and distance. Each time the formula was applied the intermediate set of temperature values was stored in the machine's memory. These were subsequently checked by another formula when the end of the time interval had been reached. The check served to monitor the accuracy of the computation.

To determine the significance of the results the process was repeated, computing the temperatures for x values (distance intervals) much closer together and with smaller time intervals. The machine compared the temperatures for common points and, if agreement was satisfactory, continued the computation for a second time interval. When forty such time sets were completed and checked the binary results for the fortieth set were converted into decimal equivalents and printed out, along with a count of the number of sets. The forty-set cycle was repeated until the initially specified temperature was reached. At the end of that computation cycle the machine stopped, ready to accept the next problem.

Six hundred sets were computed in all, comprising over 30,000 points. At each point the machine evaluated the function $e^{-1/\theta}$ by a series expansion into Chebyshev polynomials. Each temperature value was examined to determine whether or not the time limit had yet been reached. As the computations progressed the machine had to keep a running check on the availability of storage space in the memory for the ever-increasing list of temperature values corresponding to the flow of heat in the x direction.

SEAC is but one phase of the digital computers programme of the National Bureau of Standards. This programme embraces funda-

mental research, engineering development, design and construction, and technical services. It involves work in both mathematics and electronics and has been carried out in the Bureau's Applied Mathematics Division and Electronics Division. The engineering aspects of the fundamental research phase are concentrated at the Electronic Computers Laboratory, a section of the Electronics Division devoted to research, design, construction and consulting service on problems associated with computer equipment. Recent work has dealt with certain critical computer needs, such as efficient memory systems, high-speed switching and increased reliability of electronic components.

A second machine, the National Bureau of Standards Western Automatic Computer (SWAC), has now been completed in the Los Angeles laboratories of the National Bureau of Standards.

Reconstructed Oil Engine Factory

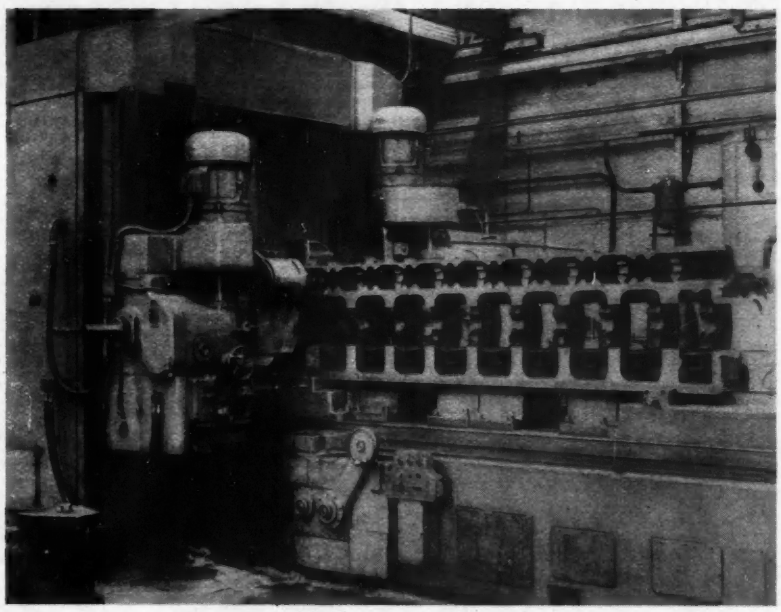
IN Lloyd's Register annual report for 1950 a propulsion analysis table, covering a period of twenty-five years, indicated the recession of the steam reciprocating engine as a prime mover and the remarkable rise to favour of the oil engine. This increasing demand for the diesel engine, which has been very noticeable for trawlers, colliers, coasters, in addition to vessels requiring greater power, has stimulated production, the introduction of modern methods and also increased capital investment for the purchase of new machines.

Among the firms which have made great strides in this direction in recent years is British Polar Engines, Ltd. The company, since 1946, has been engaged upon the reconstruction and extension of its works, and the careful planning of production flow to meet not only current orders, but the anticipated all-round increased demand for the various sizes of engines. The scheme has entailed a complete reorganisation of the works, the building of new shops, the resiting of existing machinery and the introduction of new special-purpose machines to perform duties which previously involved costly setting up and several operations by older machines. Increased test bed facilities have been provided and the whole factory lay-out, from the point where the raw material or component part leaves the improved storage facilities to be progressed through the shops from machine to machine, has been planned so that each operation contributes to the efficiency of the works as a whole. The new section of the works has been erected for the sole purpose of manufacturing the smallest size of "Polar" engine (type "E") and is completely equipped with new tools and modern high-efficiency machines. The maker of "Polar" engines is one of the few manufacturers using its own design of fuel pumps, so that a new department for the production of fuel-injection equipment has been formed.

As a result of the reorganisation the annual output has been more than doubled during the last four years, having risen from 25,000 b.h.p. in 1946 to a level of 60,000 b.h.p. by 1950, the latter figure including 40,000 b.h.p. from the old factory and 20,000 b.h.p. from the new.

At the invitation of British Polar Engines, Ltd., we, in company with other members of the technical Press, were accorded the opportunity of making a detailed tour of inspection of the Company's Govan Works. Apart from the actual production side of the works it was of considerable interest to note the attention paid to the humanities. Applicants for apprenticeship are tested by modern methods, in addition to a written examination, to assess their aptitude for engineering and the results assist the instructors in determining which particular aspect of their pretraining should be stressed. In the recently established apprentices' school, boys are given six months' intensive training before entering the factory proper. A minister of a local church teaches the boys English, mathematics, science, economics and citizenship, and, in addition, performs the duties of a welfare officer for the whole factory. An excellently staffed and appointed hospital takes care of the health of the employees and the figures for absenteeism due to sickness or to accident are given as 2·66 per cent and 0·37 per cent respectively. During the reorganisation the opportunity was taken to review the accountancy system and, as a result, Hollerith electrical punched card equipment was adopted and has been extended to cover every aspect of the company's operations so that a statistical record is instantly available.

British Polar Engines, Ltd., was adopted as a title in 1944, but the company under the name of British Auxiliaries, Ltd., was engaged in building "Polar" auxiliary diesel engines over twenty years ago. The increasing demand for oil engine propulsion, for short sea traders and vessels engaged in similar duties, brought the company its first order for a main engine. Two five-cylinder diesel engines developing a total of 1250 b.h.p. at 220 r.p.m. were built and installed in 1933, in the "British Coast," and they are still in active service. From that time the production of main propulsion units steadily increased until they formed the greater proportion of the output of the company so that the change of name made in 1944 was in accordance with the main activities of the company. To-day, over 60 per cent of the oil-engined vessels which come within the British Polar power range are fitted with engines built by the company. Among recent ships so equipped may be mentioned the "Mombasa," "Saint Ninian," "Star of Scotland," and engines are on order for ships building for, among others, the Ellerman's Wilson Line, Ltd., and the Isle of Man Steam Packet Company, Ltd. Large numbers of engines continue to be built for ships' auxiliaries and also for service in various land installations.



DUPLEX PLANO MILL

Description of Engines

The single-acting, two-stroke British Polar engines are built under licence from Nydqvist and Holm, of Trollhättan, Sweden. They are built as direct reversing marine or stationary engines, both designs being identical with regard to the main working parts. Present production covers three sizes of engines, namely, Marks "M," "I" and "E," and they have cylinders with a diameter and a stroke of 340mm by 570mm, 250mm by 420mm and 180mm by 300mm, respectively. The "M" and "I" engines are produced in the old factory and the "E" engine in the new.

All engines are of trunk piston design and have angled ports in the cylinder liner for the admission of scavenge air and the discharge of exhaust gases. Scavenge air for the two larger engines is supplied by a double-acting reciprocating pump placed at the forward end of the engine and driven direct from the crankshaft. On the "E" engine a centrifugal blower is fitted and driven by gearing from the crankshaft; there are two impellers, one for ahead running and one for astern, and an automatic change-over which is operated by an air-starting manœuvring slide. Air is conveyed to the cylinders through a manifold placed below the exhaust pipe and the exhaust gases are prevented from entering the scavenge trunking by automatic valves arranged between the manifold and the cylinder ports. The scavenging air valve arrangement is of special design and is manufactured under licence by other builders for fitting to other oil engines. It is of leaf spring pattern and can be built up to any size the parts being used for the suction and discharge of the scavenge pump and for the non-return valves on the cylinders. It was noted that the discharge cover on the scavenge system was a light alloy casting.

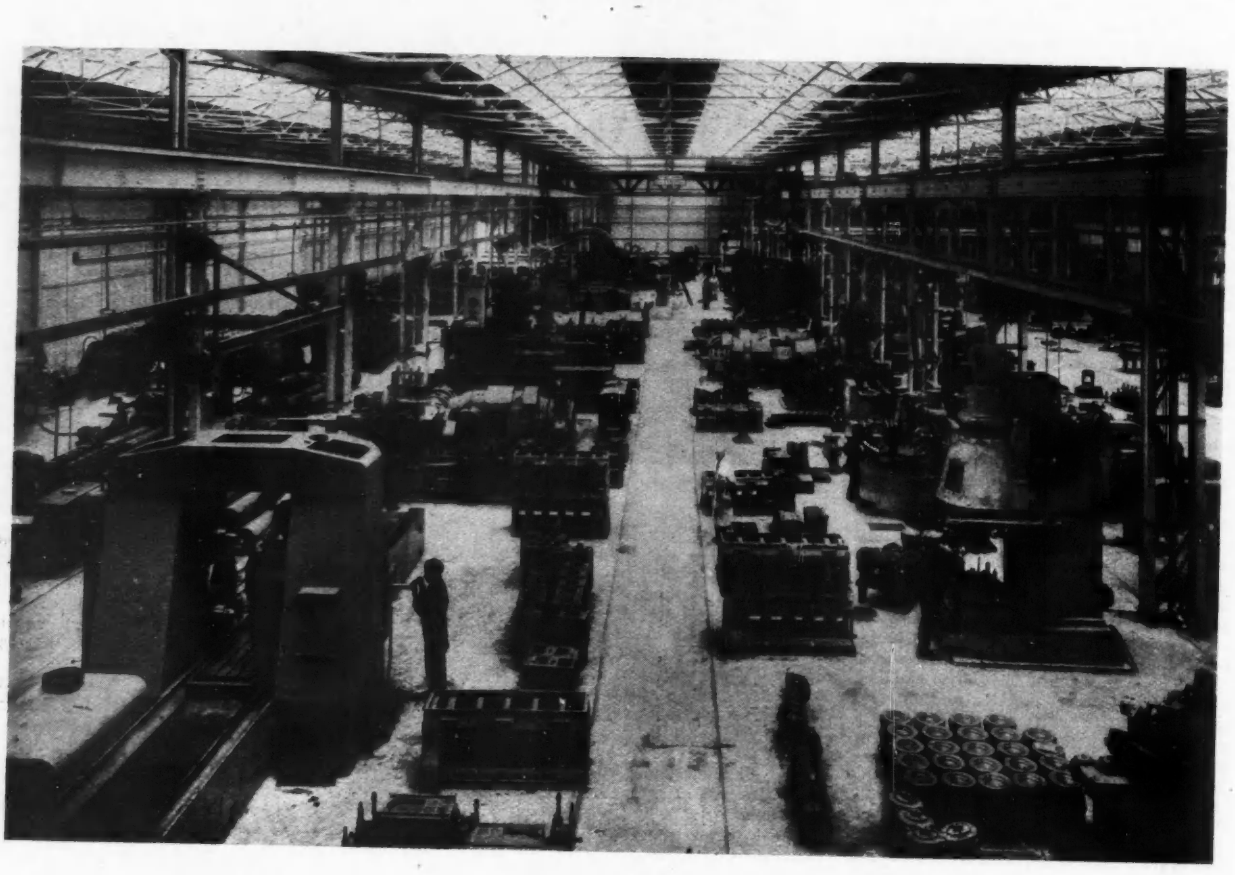
Compressed air is used for starting on all the engines, and the air starting valve is of particular interest, being so arranged that it cannot open if for any reason the pressure in the engine cylinder is too high. Compressed air is used as an opening medium instead of cam mechanism. The air is passed to a rotating sleeve and thence through ports to a piston on the top of each starting valve and the air pressure opens the valve by compressing the spring which holds the valve shut. The air escapes from the piston chamber through ports spaced upon a timing basis, and spring pressure closes the valve. Axial movement of the rotating sleeve brings another series of ports into operation when running the engine in reverse.

Simplicity in construction results from the adoption of the two-stroke principle which eliminates the complication of valve gear for suction and exhaust valves. The only working valve in the cylinder head is for fuel injection purposes; it is of automatic needle design operated by the pressure of the oil, and the body is adequately cooled and fitted with a fuel filter. By using this design of valve no

A RECONSTRUCTED OIL ENGINE FACTORY

BRITISH POLAR ENGINES LTD., GOVAN

ENGINES ON TEST BED



NO. 2 BAY "E" SHOP

long camshaft, cams or valve gear are required, and only a short camshaft is necessary for driving the fuel pumps, of which there is one for each cylinder. The pumps are mounted on a bracket at the control point on the front of the engine, and so arranged that removal for examination is a comparatively simple matter of removing two bolts and keys after breaking the oil connections. The pumps incorporate a hardened steel plunger working in a hardened steel liner and are driven through a special coupling which ensures that fuel is not delivered until the engine is rotating in the direction desired. A lever at the control platform regulates the quantity of fuel by limiting the effective stroke of the plunger, and delivery is at a pressure of 150 atmospheres. There is a fuel filter in the suction line.

The bed-plates for the larger engines can be made in cast iron, but are increasingly of welded fabricated steel plate construction. Cylinder frames are of cast iron or welded steel and the cylinder blocks are of cast iron arranged in pairs and fitted with removable wet liners having copper bands fitted as gas seals. The castings, after machining the faces, are assembled and fastened to the bed-plate by long through bolts which take up the tensile stresses. To facilitate the cleaning of the ample water-cooling spaces, the cast iron cylinder covers are in two parts, while the radial arrangement of the water system makes for efficient cooling.

Cast iron is used for the pistons which are in two parts, and are oil cooled; the crown, which has a slight taper, fits over the oil distributor on the skirt. The system provides efficient cooling for the crown and piston rings, and the oil, which is taken from the main lubricating system, is delivered under pressure through a drilling in the connecting-rod and discharged through telescopic pipes to the crankcase. A non-return valve of simple design fitted at the foot of the connecting-rod serves to retain the oil at gudgeon pin level and to prevent inertia surging. An oversize forged steel crankshaft having white-metal bearings is fitted. The connecting-rods which are of the same material, are machined all over and have bottom end bearings of cast steel, lined with white metal, and top end bearings of bronze. All the principal bearings are forced lubricated, the oil being delivered, by a gear-pattern pump driven through gearing from the crankshaft, after passing through a filter and cooler. A gunmetal cooling water pump of double-acting reciprocating design, driven from the crankshaft, delivers water to the cylinder jacket and covers.

The foregoing description of the "M" and "I" engines applies generally to the smaller "E" design, but, because of dimensional limitations and other reasons, the specification of the latter engine differs on certain points. Pistons and cylinder covers are in one piece, two lubricating oil pumps are fitted, a vane-pattern scavenge pump is supplied, liners are water cooled above the ports, while the lower portion is cooled by the incoming scavenging air, and the engines develop approximately 50 h.p. per cylinder at 600 r.p.m.

The "M" class engines are built in six sizes ranging from the four-cylinder model developing 640 b.h.p. at 250 r.p.m. to the nine-cylinder engine of 1440 b.h.p. at 250 r.p.m., both engines being rated to give 750 b.h.p. and 1700 b.h.p. respectively at 300 r.p.m. Four sizes of Mark "I" engines are produced from the four-cylinder model of 310 b.h.p. to that of seven cylinders of 545 b.h.p., both running at 300 r.p.m., the power developed at 400 r.p.m. being 400 b.h.p. and 700 b.h.p. respectively. The small "E" engine has a horsepower range from 200 to 365 at a speed which varies from 500 to 600 r.p.m. All marine engines have built-in Michell thrust blocks and are provided with the necessary auxiliaries.

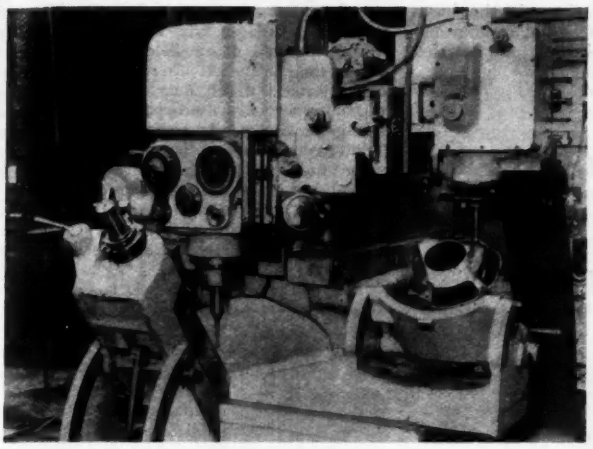
Machinery installations of larger output have been installed, without fitting a large size diesel engine, by gearing two or four engines to one shaft and using hydraulic or magnetic slip couplings. This system was adopted for the Admiralty "Bustler" class tugs and a recent example of a merchant vessel was the oil tanker "Atlantic Duchess." This vessel was fitted with two Gray-Polar six-cylinder engines, each rated at 2400 b.h.p. and connected to a single shaft through a gearbox incorporating hydraulic couplings.

Factory and Machines

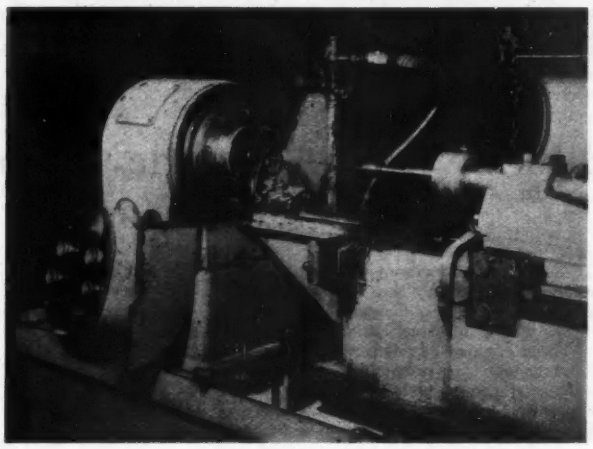
The "M" and "I" factory is planned in six bays with stores arranged across the ends of the bays. No. 1 bay stocks the bar material and contains mostly capstan machines, while the next bay forms the light machine shop. Bays numbered 3 and 4 are arranged for medium and heavy machining operations respectively, and No. 5 is devoted to the assembly of components such as control gear and scavenging valves, while No. 6 forms the erecting shop with space set apart for engine testing. One of our illustrations shows a number of engines on test. The new "E" factory is divided into four bays with the stores for stock material and finished parts right across one end of the bays. Capstan lathes are arranged in No. 4 bay, where bar work and light machining operations are carried out and where the incoming goods are accepted and then distributed. Light machines are assembled in No. 3 bay together with the water test and the sub-assembly section, and in No. 2 bay, illustrated on page 218, are sited the heavier machines and the test bed, which is well equipped and large enough to accommodate several engines at the same time. On the occasion of our visit it was interesting to note that a generating set was running on boiler oil having a viscosity of 1540 seconds Redwood No. 1 at 100 deg. Fah. The apprentices' school is located in No. 1 bay, and also the tool service department.

With only three cylinder sizes in use, and a large number of engines on order, mass production methods have been made possible in some instances and it was noticed that several of the operations were jigged. During our tour of the shops a number of interesting machines were observed. There was a Cincinnati duplex Planomill with six cutter heads; it is mainly used for machining crankcase castings which it does in three operations. In one of our illustrations the caps of the crankshaft and camshaft bearings can be seen being machined, while the milling cutters on the other side are machining the bed plate feet. A Cincinnati "Hydro-tel" hydraulic copying machine was seen machining the exhaust and scavenge ports in a cylinder. This special purpose machine, which is illustrated on this page, has two heads, and performs the finishing operation on the ports which are already cored out.

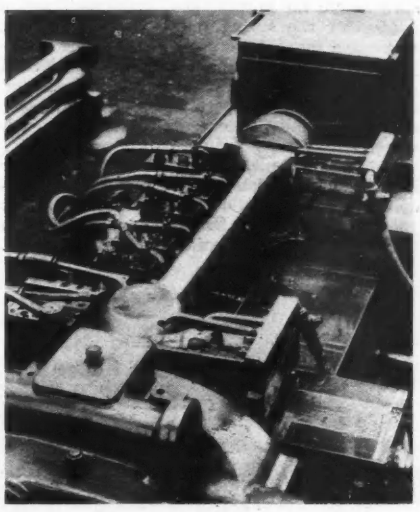
A single-point boring machine, which was designed by the company and built to its own specification, is used for boring out liners and gives a finish which does not require final grinding. For the external machining of cylinder liners a Herbert No. 14 lathe, fitted with a high-power motor, is in use. Archdale multi-spindle vertical drilling machines are employed for drilling cylinder frames, heads and bearing caps. A Schiess Defries drilling machine is available for boring long holes through crankshafts, and is capable of boring a hole 10ft. in length at one setting. Connecting-



HYDRAULIC COPYING MILLING MACHINE



DEEP HOLE DRILLING MACHINE



MACHINING CONNECTING ROD

rods are turned on an interesting machine—a Maximatic lathe, which is seen in one of our illustrations. It is a multi-tool machine with preset controls governing the slides, and can complete the turning operations on a rod in one hour. The big-end and little-end bolts are machined from forgings on a Fischer hydraulic copying lathe. All gudgeon pins and bottom-end bolts for the engine are ground in a centreless grinder. The scavenge pump fan rotors for the "E" engine, which rotate at high speeds and therefore require careful balancing to avoid causing out-of-balance forces, are checked on an Avery balancing machine.

In a separate building the fuel-injection equipment is manufactured and two designs of pump are produced. Much of the equipment in the shop consists of Beckler automatic machines which are used for making the small parts of the injection assemblies such as sprayer needles, valve needles, nozzle spindles, and other valve fittings. An Archdale long-hole horizontal drilling machine, which we illustrate, operates on an automatic cycle and drills the fuel delivery passage, while the fine sprayer holes are cut on a hand-controlled sensitive drill with a magnifying glass attachment. The grooves in the pump plungers are cut on a Cincinnati vertical milling machine in which the helix angle is controlled by a master scroll.

The company has its own pattern shop, which is fully equipped with modern machines, and has also acquired a foundry, within reasonable distance of the main works, to ease the casting supply position. Finally, there is the heat-treatment shop where carburising and hardening processes and shot blasting are carried out.

230 h.p. Diesel-Electric Locomotive for a Steel Works

TWO diesel-electric locomotives were recently designed and built by the Yorkshire Engine Company, Ltd., of Sheffield, for service in the steel works of Steel Peech and Tozer, Ltd. These engines have been specially built for the high starting tractive effort and good low-speed performance required in heavy industrial operation and where severe curvature of the track and height restrictions exist. Each engine weighs 44 tons in full working order, and has a starting tractive effort of 24,000 lb. One of the new locomotives is illustrated in the photograph we reproduce below.

Each of the locomotives is of rigid frame design and is carried on two axles, with wheels 3ft 6in diameter on the tread, coupled together. Heavy steel and iron castings incorporated in the structure of the locomotive increase the adhesive weight and give added strength for the very heavy duties encountered in service. In addition to standard buffer gear, the locomotive has at front and rear a very heavy cast buffer beam carried on spring-loaded shock-absorbing gear. Both hook and pin couplings are fitted.

The body is carried on overhung laminated springs and the horn blocks, which incorporate guides for the spring pillars, are fitted with renewable manganese steel liners. The inside journal axleboxes have renewable leaded phosphor-bronze liners. A fully compensated clasp brake system operates on all four wheels, and has an independent air cylinder for each wheel.

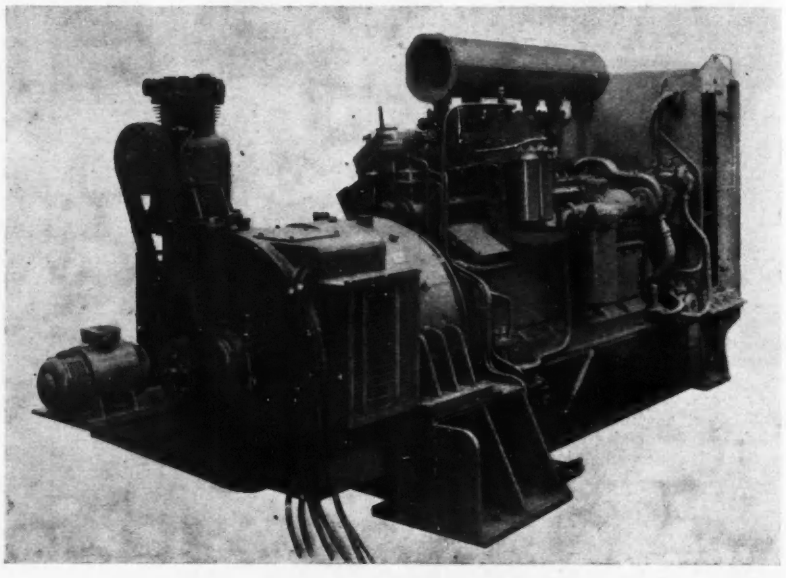
The power unit, shown in another of our illustrations, consists of a Davey Paxman six-cylinder oil engine developing 230 b.h.p. at 1250 r.p.m., driving a British Thomson-Houston three-winding, self-ventilated d.c. generator. The "6-RPHL" Series 1 engine has a bore of 7in and a stroke of 7¼in. Its underslung crankshaft is carried in seven bearings secured by tie-rods to the crankcase. The cast iron cylinder heads, arranged three in a block, incorporate Ricardo-Comet combustion chambers, and carry the valves and enclosed rocker gear. There is a C.A.V. fuel pump, gear driven from the camshaft, and single-hole, pintle, spring-loaded injectors are fitted. A centrifugal governor driven from the camshaft operates the control valve of a servo piston controlling the fuel pump regulator and, if the pressure of the operating medium falls, the engine is automatically stopped. Engine starting is by a self-engaging C.A.V. motor driving a toothed rim on the coupling, and this motor is supplied from a 24V battery charged from an engine-driven generator.

The single bearing generator of the locomotive has the non-bearing end of its armature solidly coupled to the engine crankshaft. This three-winding generator has self-excited and separately excited shunt fields and a differential series field. It has an inherently drooping characteristic which cuts the constant horse-power hyperbola at two points, between which the generator tends to overload the engine. The engine, however, is operated with a maximum fuel stop so that during this overload period, not being able to get more fuel, it loses speed. A drop in speed reduces the output from the generator and lessens the effect of the self-excited shunt field until balance is achieved.

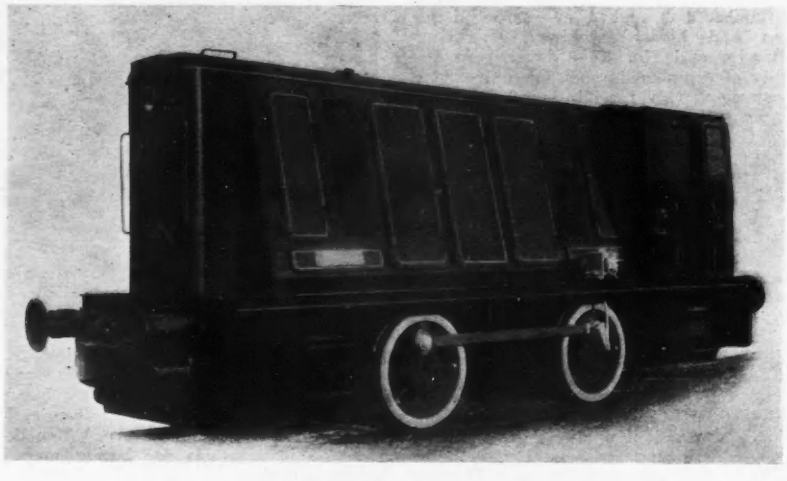
An exciter is provided to energise the separately excited field of the main generator. This exciter is a lightly saturated machine, and is extremely sensitive to speed variation; only a small drop in engine speed reduces the excitation of the main generator appreciably, to achieve balance. This drop in engine speed is never sufficient to cause serious loss of available engine power, and the average utilisation of engine power is of the order of 96 per cent. By this arrangement it is impossible to overload the diesel engine beyond a predetermined maximum output even with the locomotive stationary and the engine running at full speed.

Each axle is driven by a B.T.H. reversible, series-wound, self-ventilated traction motor through a double reduction gear housed in an axle-borne, oil-lubricated gearbox. The spring-loaded, nose-suspended motors are arranged longitudinally between the main frames to give a right-angle drive and are hung outwardly on the axles through the gearbox ends. In the gearbox spiral bevel gears give the first and straight spur gears the second reduction, the overall ratio being 19·75/1. With this ratio locomotive speeds up to 25 miles an hour are permissible, and provision is made in the gearbox to disengage the gears by sliding the lay shaft should it be required to tow the locomotive at higher speeds.

Mounted on a common bed plate with the



POWER UNIT OF DIESEL-ELECTRIC LOCOMOTIVE



DIESEL-ELECTRIC STEEL WORKS LOCOMOTIVE

power unit is a Serck radiator for cooling the water and lubricating oil for the engine. This radiator is situated in a separate compartment in front of the power unit, and its air is drawn in through louvres in the sides of the bonnet by an engine-driven fan, and discharged vertically through a grill. At each end of the power unit compartment a bulkhead isolates it from the cab and the radiator compartments. Louvres at the side of the power unit compartment direct the ventilating air to the generator through Vokes dry filters, and a slight positive pressure is maintained, after providing sufficient air for the engine, to prevent ingress of dust. Set below the power unit compartment between the axles is a 200 gallons capacity fuel oil tank, which provides sufficient fuel for ten days' continuous service under average conditions.

The locomotive is driven by means of a single lever which controls, through mechanical linkage, the engine speed. Initial movement of this lever excites the generator and further movement increases engine speed smoothly to a maximum, after which it permits field weakening of the traction motors to be effected under relay control. Reversal is effected by means of a pneumatically operated reverser, which changes the connection of the traction motor fields.

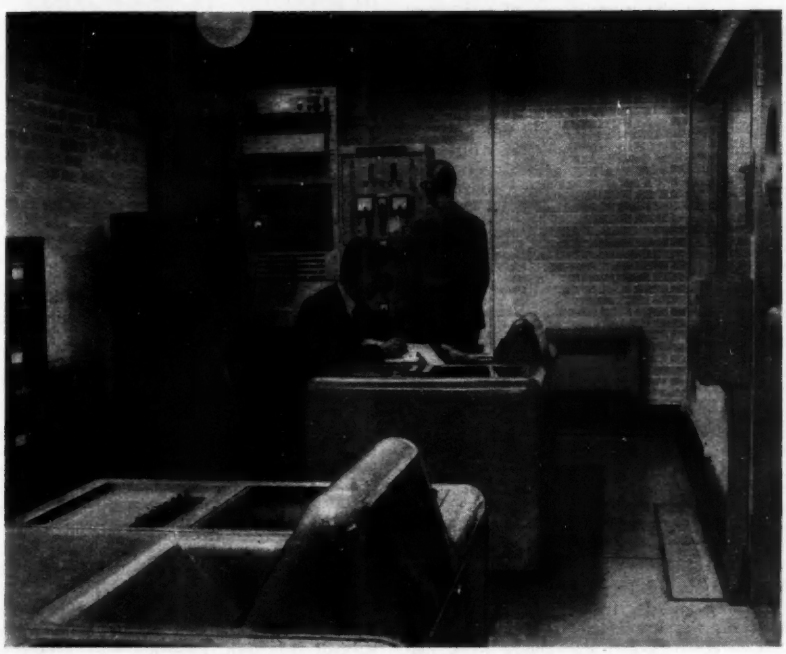
The fundamental control circuit consists of the generator and exciter and the two traction motors connected in parallel, there being no main contactors in the traction motor circuits, which are permanently connected to the generator. When the locomotive is standing at rest with the engine idling, the separate field of the exciter and the main generator separately excited field are de-energised. There is no danger of the main generator building up on residual magnetism since any tendency to do this would be counteracted immediately by the effect of the differential series field.

When the driver's controller is moved from idle to the lowest running speed, a contact energises the exciter field and closes the contactor in the main generator separately excited field circuit before the locomotive moves.

V.H.F. Transmitting Station at Wrotham

AT the invitation of the B.B.C. we recently visited the v.h.f. transmitting station at Wrotham, Kent, where a programme of experimental work is being carried out by the B.B.C. engineering research department to get first-hand information on the possibilities of broadcasting on very high frequencies.

The first tests which began in 1945, were comprehensive but they did not show conclusively whether amplitude modulation (AM) or frequency modulation (FM) would be superior for this purpose; therefore, it was decided, as a long term project, to carry out comparative tests at high power. To this end a new transmitting station was built at Wrotham and has been making experimental transmissions for the past few months. During that time some sixty listeners, drawn from the B.B.C. staff and equipped with special short-wave receivers, have been making reports on the reception of v.h.f. transmissions from Wrotham. Although the research programme has not led to any pronouncement being made about future developments of v.h.f. broadcasting by the B.B.C., the current work is significant in view of the serious congestion in European long and medium wavebands and the relevant observations made in the Beveridge report. If, therefore, our visit to Wrotham did not enable us to refer to the results of the experimental work we were, at least, able to see the test equipment installed and in use.



F.M. CONTROL DESK AND MONITOR PANEL

V.H.F. Transmitting Equipment

The station is on Wrotham Hill, one of the highest points in Kent, just off the main London-Folkestone road, about 20 miles south-east of London. It consists of a single-storey brick building and a 470ft mast, the base of which is 730ft above sea level. The building, which is similar to that of the Sutton Coldfield television station, has two wings, in one of which are the AM and FM transmitters, a control room and auxiliary equipment and in the other a quality-checking room, offices and canteen. The elevations are to designs by London architects, Messrs. Wimperis, Simpson, Guthrie and Fyffe, FF.R.I.B.A.

The FM transmitter, manufactured by Marconi's Wireless Telegraph Company, Ltd., has a power of 25kW and operates on a mean carrier frequency of 91·4 Mc/s (corresponding to a wavelength of 3·28m), with a maximum deviation of ±75 kc/s. It incorporates the Marconi "F.M.Q." system of frequency modulation, in which a quartz crystal oscillator is connected through a quarter-wave network to a balanced modulator, the susceptance of which varies with the modulating signal, and in turn varies the frequency generated by the crystal oscillator. The crystal is specially cut so that it does not produce spurious harmonics within the operating range. The chief advantage claimed for this system of frequency modulation is that the circuits are much simpler than those of other methods and therefore more reliable and easier to maintain.

The output of the crystal oscillator is passed through three frequency doubling stages and one tripling stage to produce the carrier frequency of 91·4 Mc/s. There then follow six stages of amplification. The first two are conventional push-pull stages, and the remaining four are single-ended earthed-grid stages with coaxial-line tuning elements. The output stage consists of two BR128 valves in parallel, giving an output of 25kW. Supplies at 6kV and 3kV for the valve anodes are obtained from hot-cathode mercury-vapour rectifiers in the power-conversion plant, which is installed behind the transmitter. The filaments of all the valves are a.c. heated.

The AM transmitter, also manufactured by Marconi's Wireless Telegraph Company, Ltd., has an unmodulated power of 18kW and operates on a carrier frequency of 93·8 Mc/s, which corresponds to a wavelength of 3·20m. The drive equipment and the radio-frequency amplifiers are like those in the FM transmitter, except that the balanced modulator in the "F.M.Q." drive is made inoperative. The audio-frequency modulator has four stages, the final stage consisting of two ACT 14 valves operating in class "B" push-pull, which modulate the output stage of the transmitter. Supplies at 9kV, 4·5kV and 3kV are obtained from hot-cathode mercury-vapour rectifiers in the power-conversion equipment behind the transmitter.

Both transmitters are controlled and monitored in a single kiosk. The kiosk (a view of which is reproduced herewith) has windows looking out on the transmitter hall, so that the engineer on duty gets a clear view of the transmitters he is controlling. On each control desk are switches controlling the supplies to the various stages of the transmitters and meters, indicating the voltages and currents to them. Special monitoring equipment is installed for measuring the frequency deviation due to modulation and for checking any shift in the mean carrier frequency.

Air-blast cooling is used throughout in both transmitters. The air can either be circulated round a closed system, so that it may attain its working temperature quickly, or be drawn in from outside the building. During cold weather the air can be discharged into the transmitter hall to warm it. Motor-driven dampers operated by thermostats control the circulation of the air automatically.

A concentric feeder connects the output of each transmitter to a change-over switch through a filter for minimising harmonic radiation. By means of the change-over switches the transmitter outputs can be connected either to the feeders leading to the aerial or to test loads. The test loads, which are identical, consist of short lengths of concentric feeder through which water is circulated. The power is dissipated in the water, which is obtained from a supply unit, where its temperature is quickly raised to a predetermined value and then kept at that value to prevent variations in the impedance of the load.

From the changeover switches the transmitter outputs are connected by concentric feeders, having an impedance of 51 ohms to a combining filter, which prevents power from being fed from one transmitter to the other. This filter, which is outside the transmitter building, consists of sections of concentric line. The FM and AM signals from the filter are carried up the mast to the slot aerial system by a single concentric feeder.

The mast is some 50 yards from the transmitter building. It consists of a lattice steel support mast 360ft high, on top of which is a cylindrical section 110ft long and 6½ft in diameter, which, with the slots in its surface, forms the v.h.f. aerial system. The support mast has a triangular cross-section, each face being 9ft across, and rests on a ball joint, which permits some angular movement under wind pressure. The dead weight of the mast is 60 tons and the maximum thrust at the base is 200 tons. Nine stays, attached in sets of three at 160ft, 360ft and 470ft above the ground, hold the mast erect. The mast was designed and built by British Insulated Callender's Construction Company, Ltd.

The aerial system, which is common to both transmitters and radiates horizontally polarised waves, consists of thirty-two slots in the surface of the cylindrical section, arranged in eight tiers, each tier having four slots spaced at 90 deg. intervals round the surface. Each slot is 8ft high and 1ft wide and is screened by backing it with a series of horizontal bars placed one above the other at 1ft intervals. In the centre of one half of each slot and parallel to the edge, is a rod, approximately half a wavelength long, one end of which is connected to the surface of the cylindrical mast and the other to the driving feeder. Each slot operates as a folded slot. This arrangement reduces the input impedance of the slot from approximately 600 to 150 ohms, a value which is more convenient for feeding by coaxial cable. All the slots are fed with currents of the same amplitude and phase. The aerial was designed in the B.B.C. engineering research department. The associated feeder system was developed and manufactured by Marconi's Wireless Telegraph Company, Ltd. The aerial is suitable for any frequency within the band 87·5 Mc/s to 95 Mc/s, and has a mean power gain of approximately 8 decibels, which does not deviate by more than ±1 decibel in any horizontal direction.

The station is supplied with power at 11kV, three-phase, 50 c/s, by duplicate feeders, which terminate on switchgear in a substation near the transmitter building. This supply is transformed down to 415V and distributed from the low-voltage switchroom in the transmitter building to the transmitters and auxiliary equipment. A 50V supply for the transmitter control circuits is obtained from metal rectifiers and there is a 240V battery for emergency lighting.

Annual Report of The Electrical Research Association

THE thirtieth annual report of the British Electric and Allied Industries Research Association (the E.R.A.) was presented at the Association's annual general meeting on Friday, February 9th, in London. We reproduce, herewith, extracts from the report to give a general indication of some of the Association's research activities.

Research

Among the large—possibly speculative—projects, large-scale electricity generation from wind-power is now in full swing. By the time this report is issued it is hoped that a 100kW generator will be installed in Orkney by the North of Scotland Hydro-Electric Board. Another should shortly be installed in Wales or Cornwall by the British Electricity Authority, with possibly others of similar or less capacity elsewhere. The E.R.A. has already made detailed studies on probable sites and is making or will make much more detailed studies on actual sites so as to permit the fullest information to be gained from operating experience. In parallel, substantial programmes on costing and design have been made possible by contracts placed by the Ministry of Fuel and Power. The Association's wind survey is being extended in Great Britain and also to Northern Ireland (with the support of the Ministry of Commerce) and Eire (with a special contribution from the Eire Electricity Supply Board). Model tests on site selection proceed in the laboratory.

The work at the National Physical Laboratory on high-temperature carbon and molybdenum steels, under the ægis of the Association jointly with the steel industry, and latterly through the British Iron and Steel Research Association, ended in 1950. The technical achievements and great financial savings accruing from this research have been adequately documented during its long history, the period of which from 1930 to 1949 has just been reviewed. It now suffices to point to the increased generation efficiency and the vastly increased temperatures and pressures rendered possible in modern practice. The Association faces the next difficult step of determining the type of materials for higher temperatures, which retain the desirable properties of ferritic steels but have adequate creep and corrosion resistance at the higher temperatures. Apart from creep tests already in hand and to be extended, it is intended to test a rotor forging and to open up new facilities for work on corrosion,

A plan is now complete for a full-scale trial of high-voltage transmission, using direct current, so that the industry can see just what is involved. Progress on so large a project has necessarily been slow but meanwhile the E.R.A. model system has produced useful results on starting, hunting of conversion plant and operation near the minimum of reactive kVA.

Although not among the most costly studies, the investigation of lightning has become nation-wide by the recruitment of voluntary observers and collaboration with Area Boards. Routine maps are prepared of thunderstorm locations. The returns of fault statistics, for which the Association is indebted to a large number of supply engineers, are supplemented by visits and discussions bearing not only on the frequency of lightning incidents, but also on the effects and remedies. Checks on lightning arresters have been made for Area Boards, and the N.P.L. is making surge current tests on arrester discs. Data accumulate from the patrolled magnetic links, and an attempt is envisaged to photograph lightning in daylight. The study of indirect lightning surges on 11kV lines is complete and the theory of lightning strokes to insulated cables has been extended.

The hydrogen-oxygen cell has reached the stage where certain alternative lines of progress are apparent, but to pursue any one of them will need a higher scale of effort. A conference of interested parties will shortly be called to make recommendations. Some points on conventional batteries are under examination.

The support of the Ministry of Agriculture and Fisheries has justified the expansion of the Shinfield Station, the only field station exclusively devoted to rural electricity, by a new building and by full-size glasshouses for research on the application of electricity in glasshouse cultivation. Previously work had been confined to warmed propagating benches on an "amateur" scale. Barn hay drying incorporating in the technique a novel form of elevator can now be confidently recommended and the scope of the Swedish method of hay drying will soon be established as also that of the all-electric grain dryer.

The pilot network analyser has already been used with external metering. Its success so far suggests that its subsequent behaviour will justify extension to full scale operation and consequently heavy capital expenditure in the next year or so.

One of the fundamental problems of switchgear research is that of zero-pause phenomena, including the glow-arc transitions and arc re-ignition, where high-speed photography (including a colour film of unusual effective speed) and the capacitor discharge technique have made important contributions. Another problem is the aerodynamical effect of the arc on gas flow, where again high-speed photography has been useful. Associated mainly with the first problem is the further development of the energy balance theory of arc severity and arc extinction. In addition there have been pursued a number of shorter term studies, some inherent in the group of researches and some directly proposed by members. They include the distribution of recovery voltage with series breaks, arc chutes and magnetic blow-outs, variation in controlled repeat tests, the use of capacitor discharges and deleterious effects of carbonisation of switch oils. An important stage of the survey of restriking voltages in British systems is complete and another stage continues. Some specific points have been settled, such as pressures in oil tanks in certain instances and some special cases of non-clearance.

Present work on fuses bears on the difficult current regions for fuse operation, effect of circuit constants and arc re-ignition. Provision is now available for higher-power tests on contactors, with particular reference to the revision of British Standards.

Twenty-five years ago the E.R.A. set itself the problem of dielectric breakdown. With the publication this year of the effect of dipoles on temperature coefficient, exemplified in polyvinyl alcohol, intrinsic breakdown seems to be settled for practical purposes. Thermal breakdown had been disposed of before the war. This year saw a stage complete in breakdown by discharges, whereby the origin, nature and mechanism of discharge breakdown is qualitatively described and attention can now be directed to completing the quantitative analysis. Arising from the fundamental researches, means of attack have appeared on even wider questions, including the general theory of electrons in solids where a first stage was completed this year.

Transient processes in gaseous discharges are a main interest and are being pursued with new techniques both at the N.P.L. (impulse corona) and at Liverpool, where a most interesting attack is in progress on the fundamental mechanisms of the discharge channel. In some considerations on cosmical discharges the processes may be conceived as expanded to long times. Somewhat allied are the questions of breakdown at high frequencies and at centimetric waves where notable progress has been made in describing the new features peculiar to these regions. The hollow-cathode effect in ordinary discharges has an application to illumination sources. Proposals for the revision of the standard spark-gap calibrations are in an advanced stage.

Steam

For work on the properties of high-pressure, high-temperature steam at the Imperial College of Science under Professor D. M. Newitt, it has been decided to measure pressure, temperature and enthalpy, by the dynamic method devised by Professor H. L. Callendar and used by Egerton and Callendar in their work for E.R.A. The apparatus, however, has had to be completely redesigned, to meet the much higher limits of the present programme. Ninomic 80 has been adopted for all parts subject to high pressure and temperature. The primary pressure standard has been tested and the means of measurement refined so that the column is expected to have an accuracy of at least 1 part in 25,000 at 1000 atmospheres. This is some twelve times more accurate than any other pressure measuring device available in this country and, besides removing the inaccuracies in the pressure measurements of the properties of steam, will be an invaluable addition to the range of fundamental measuring instruments.

The main long-term general programmes on transformers are the calculation of the mecha-

nical forces and the determination of heat transfer coefficients, including the ventilation of substations. A design and specification for 275kV capacitor metering transformers has been elaborated and a prototype is expected in the near future. The corresponding problem in current measurement has given rise to some new ideas, which are being studied. Work continued on a number of specific problems, such as gas analysis for the Buchholz relay, building losses in transformer cores, the method of measurement of losses at low power factors, the general design principles of capacitor transformers, the switching of capacitors and use of series capacitors in line transmission. As the new improved magnetic materials for cores, such as oriented silicon iron, appear to have revived the problem of transformer noise, the E.R.A. Committee on that subject has been restored and new work is expected soon to begin.

Wear tests continue on meter jewels with different orientations of optic axis. In life tests on the steel/sapphire combination of pivot and jewel, a few of the original units started in 1936 are still running within the prescribed limits of friction and having a life of approximately 2000 million revolutions. Three sets of 90 deg. jewels, made under controlled conditions, are undergoing tests in the hope of eliminating the anomalous behaviour of certain jewels having this optic angle. Tests continue on jewels having optic axial angles between 75 deg. and 85 deg.

The additional tests on the small heat pump unit at the laboratory, referred to last year, have been completed. They cover a range of source temperatures from 34 deg. Fah. to 85 deg. Fah. and the use of a smaller source tank than that employed in the earlier tests. A revised draft of the preliminary report (Ref. Y/T15), incorporating the results of this work, is being prepared for issue to members at an early date. The possibility of utilising waste water from buildings as a source of low-grade heat for the heat pump is being actively studied. Considerable progress has been made with the investigations on the use of the earth as the source of low-grade heat, using the small heat pump unit operating on this principle at Perivale.

A heat pump installation has been designed for one of the buildings at the Shinfield Station. A second similar building will be heated by a conventional gas-fired boiler and radiator system, designed with the co-operation of gas engineers and scientists, and it will thus be possible to obtain a direct comparison of the performance of the two systems under identical operating conditions. Some work of an advisory nature has been done in connection with other heat pump installations, in return for which operating data of value in connection with the general study of the subject will be available.

Steel Research Laboratories at Rotherham

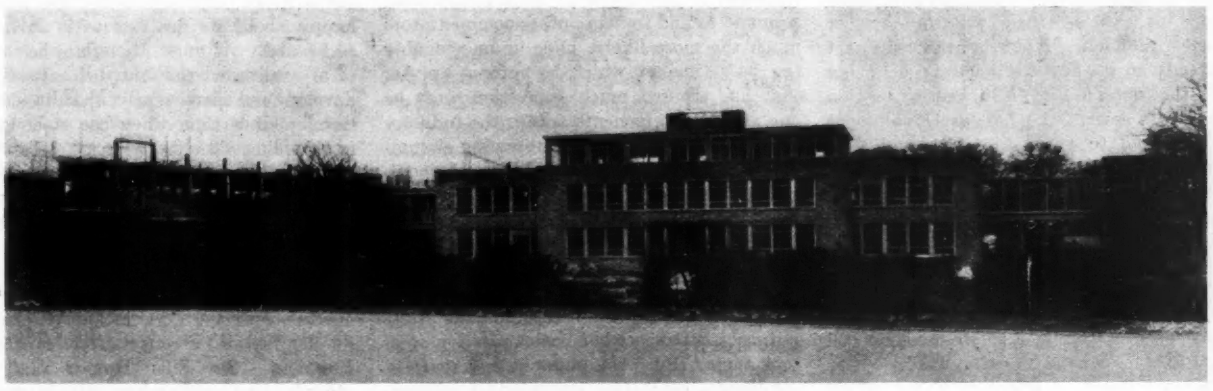
WE recently had an opportunity to see the progress that is being made with the construction of the new research laboratories at Swinden House, Rotherham, for the United Steel Companies, Ltd. These laboratories, work on which began towards the end of 1949, are being built to provide more spacious and convenient quarters for the central research organisation of the United Steel Companies, Ltd. That organisation was set up in 1930, under the direction of the late Dr. Thomas Swinden, and since then has been housed—for the most part—at the company's Stocksbridge Works, Sheffield. At the end of the war, and following the death of Dr. Swinden, it was decided to expand the activities of the research organisation, and Mr. F. H. Saniter, who was trained as a mechanical engineer and had been engaged with Steel, Peech and Tozer and Samuel Fox and Co. on the development of alloy and special steels, was appointed director of research.

The first step taken by the United Steel Companies, Ltd., in the expansion of its research department was to establish a group of development engineers to specialise in the principal items of steel works plant and equipment and to keep in close touch with new developments with a view to their early application to the company's own practice. It was also decided that more attention should be paid to the study of the raw materials on which the company depended, and a section dealing with petrology, geology and ore dressing was accordingly established. Another special group was formed to study open-hearth furnace design and was provided with laboratories in which basic data can be obtained by the use of aerodynamic and hydraulic models. The result of this expansion of research and development activities was to double the size of the organisation—the staff of which now numbers 180—and it soon became evident that the Stocksbridge laboratories were inadequate to house so many people and their equipment.

The United Steel Companies, Ltd., therefore purchased Swinden House, Rotherham, in 1946, which not only provided room for the immediate expansion of research work, but also land sufficient for the new laboratories which are now being built. The Swinden House property in fact, covers 15 acres. As the new buildings are situated on the South Yorkshire coalfield, they have been arranged in four separate blocks, connected by corridor links, and particular attention has been paid to foundations in order to minimise the risk of damage through subsidence. The two outer blocks are designed for the metallurgical, physics, welding, chemistry, refractories and X-ray sections of the research department. The central block, now nearing completion, as shown in the accompanying illustration, is to accommodate part of the administration, the development group and drawing-office, and sections devoted to petrology, furnace design, fuel and statistics. Behind it there is a workshops block, housing the machine shop, steel store, steelmaking plant, and special laboratories for work concerned with aerodynamics, water models, hot model furnaces, and for pilot plant. A separate small building contains the main electricity supply substation and gas metering equipment.

The three main blocks are steel framed, with reinforced concrete floors and roofs. External walling is cavity construction throughout, the outer facings being in "Stamfordstone" bricks, the yellowish-brown colour of which blends admirably with the surroundings. A main service tunnel runs below all the ground floor corridors, and, from it, vertical ducts give service access to all rooms. To accommodate the large number of service pipes required for the chemistry laboratories the floor of the block concerned is of double construction, the intervening space being occupied by the various pipes. The use of Appleby Frodingham castellated beams has enabled maximum flexibility in this construction, the holes in the webs of the beams being very convenient for the passage of the pipes. The workshop block has two bays, each 150ft long and 45ft wide, the space between them being roofed to form a covered corridor. For the construction of these bays rigid portal frames have been adopted, with a centre monitor some 5ft high in each bay. The sides of the monitors are fitted with vertical glazing, and large clerestory windows run down each side of each bay. The workshop bays are roofed with "Bitumetal" insulated aluminium roof decking. The mechanical handling facilities to be installed include two hand-powered overhead travelling cranes, each of 2 tons capacity.

The finished appearance of the new buildings, when they are completed, will be quite in keeping with the existing Swinden House, which will continue to be used by the research and development department. It will accommodate the director of research, the secretary of the department and his staff, the library, information officer, and the photographic section. There are also conference and dining rooms, canteen and kitchen. In addition, existing outbuildings have been satisfactorily converted to include a well-equipped ore dressing laboratory, a refractories section furnace room, and sundry workshops and stores.



SWINDEN RESEARCH LABORATORIES

NUFFIELD FOUNDATION AWARD.—Mr. R. Parker, assistant lecturer in metallurgy, University College of Swansea, has been granted a post-graduate travelling scholarship in extraction metallurgy, awarded by the Nuffield Foundation. He will spend four months this year in the U.S.A. and Canada.

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STEEL NATIONALISED

YESTERDAY the shares of some eighty companies scheduled in the Iron and Steel Act of 1949 officially vested in the Iron and Steel Corporation. So ends the controversy, which has ruled ever since the unsatisfactory election of last February, as to whether or not the enforcement of the Act ought to be delayed until the people of this country have had a renewed chance to express their will in another General Election. Knowing that the Act is already on the Statute Book and believing that the outcome of last year's election justifies its action, the Labour Government has hastened to nationalise iron and steel production at almost the earliest date the provisions of the Act permit. But though no one can dispute its power to take that action, the wisdom of the Government's haste is certainly open to question. For though the controversy upon the issue of the enforcement of the Act is now ended the future of the iron and steel industry still remains incompletely determined. That "finality" and "stability" to which Mr. Strauss referred in last week's debate in the House have not yet been reached. Unless, indeed, a very considerable body of the leaders of the industry, their loyalty in its service overcoming their dislike for the measure, acquiesce in the *fait accompli* the fate of the industry still depends upon the outcome of the next election.

The question that has been at issue, ever since the election of last year returned a Labour majority of six to the House of Commons, has not been one as to whether the Government had the power to enforce the Act, not one as to whether the provisions of the Act are good or bad, not even one as to whether the Government had or had not a "mandate" to bring the industry under public ownership, a point upon which party politicians proved able to argue endlessly. The point at issue, obscured though it sometimes was by other arguments, was simply and solely whether in existing circumstances it was expedient to implement the Act. Is this, in fact, a time at which the Act can be enforced in such a way that any of its provisions which are good will have the best opportunity to reveal the benefits they can confer on the industry and any that are not so good will have the least chance to do damage? Or will enforcement now have the reverse effect? Unfortunately, it is the latter consequence that seems to us and to many other commentators much the more likely. For unquestionably the best time at which to enforce an Act that has aroused much opposition must be one at which opponents within the industry concerned are forced by surrounding circumstance to admit the inevitability of acquiescence, and who, therefore, their loyalty to the industry outweighing their distaste for the change, will make the best they can of the new conditions. These were the conditions that faced the coal-owners, the private electricity and gas companies and the group railway companies when nationalisation overtook them. But even under such favourable conditions, conditions under which all concerned would be attempting to "make a go" of nationalisation, it would not have been easy to work out a *modus operandi* between a Steel Corporation with complete powers of control over a number of steel-producing concerns (and considerable interests outside steel-making) and an Iron and Steel Federation with voluntary co-ordinating functions over a wider range of firms, a large number still in private hands. In fact, however, those are not the conditions that rule as nationalisation overtakes the steel industry. For nobody within the industry knows how long the Corporation will continue to exist, since it depends for its present stability upon the tenuous thread of a six-Member majority in the House of Commons. The steel masters have not, therefore, so far proved acquiescent and may well see no reason for acquiescence now. In explaining in last week's debate how the Corporation and the Federation were discussing "the long-term arrangements to enable the Corporation to discharge its statutory duties and responsibilities," Mr. Strauss complained "the leaders of the Federation have not been very forthcoming so far." But how could they be? For upon the one hand, the Corporation has necessarily assumed its own permanence and has been seeking to erect a permanent new structure for its control of a nationalised industry, whilst upon the other, the Federation has no doubt been seeking, without risk of damage to an existing voluntary structure of proved worth, to reach agreement with a body that, it deems, may go out of existence quite suddenly at any time within the next few months! Under those circumstances, even if there were complete goodwill between the parties, it is difficult to see upon what common ground they could reach a full agreement, though agreement should certainly be possible in more limited fields of action. According to Mr. Strauss, they have been given a further three months in which to seek complete agreement. Are they any more likely to find it now that steel shares have vested in the Corporation than they were before?

The danger, now, is that the iron and steel industry will be ruled until the next election by a two-headed monster consisting, upon one side, of a Corporation experienced in management, but ill-representative of steel production, and, upon the other, of a fully representative Federation with the voluntary loyalty of the industry behind it; that, in fact, though all the power will be in the hands of the Corporation, that body will be reluctantly and unwillingly served by the industry. No engineering firm would feel happy about its dealings with an industry so headed. It must, therefore, be the hope of all concerned that no such situation will develop and particularly that it shall not develop at a time when the steel industry is grappling with problems of ore and scrap supply, attempting such reorganisation as may be necessary to suit the rearmament drive and beginning to plan its further expansion. No doubt it was with the object of averting some, at least, of that danger that the Federation recently offered to co-operate with the Corporation by placing at its disposal in a consultative capacity its President, Sir Ellis Hunter, and three other leading steel makers. Much, now must depend upon the attitude of the Corporation. If it recognises its possible impermanence and if it acts with tact and discretion in its dealings with the industry it now controls, no serious damage need be done before a new General Election at last decides the issue. Something, too, may depend upon the actions of the leaders of the industry. For the Government undoubtedly hopes that, faced now by a *fait accompli*, some, at least, of those leaders will acquiesce, for fear that damage to the industry to which their lives have been devoted, must be the consequence if they do not; that, in fact, four places upon the Corporation still remaining open will be filled by recognised leaders of the industry. But all those risks, all those difficulties, all the heartburn and resentment, all the uncertainty, could have been avoided!

For if the Government is convinced of the need to bring steel production under public ownership and is sure that the country supports it in that view, did it really matter, upon the longer term, whether the industry was nationalised this year, next year, or even four years hence, should the present Government last so long? Was it not of much greater importance that, if nationalisation was to take place at all, it should be imposed upon an industry acquiescent because convinced of its inevitability rather than upon one affronted and unwilling? "Raw Haste" proves often "half sister to Delay." If the Corporation survives the next election it is certain that it will take it long to live down resentment at the circumstances of its creation. If it does not survive it, what but harm can its intervention have done the industry?

ELECTRIC TRACTION PROBLEMS

According to the British Electricity Authority, electric generating capacity in this country is likely to be inadequate to meet demand for several years to come. But that hindrance to realisation does not prevent repeated debate upon the subject of main line electrification of railways in this country, a subject that has been under discussion already for thirty years or more. In assessing the benefits in railway traffic operation likely to occur from a change-over to electric traction, one is confronted with a number of dissimilar considerations—some economic, some political, some perhaps strategic—which, however unconnected they might appear in their impact upon the engineering nature of the job, nowadays form an integrated pattern when the expediency or otherwise of any particular scheme comes to be weighed up. The subject is therefore personally alive. In the field of economics alone, the advocates of electric traction, while not perhaps going so far as to claim the system of their faith as the panacea for all railway ills, do carry their proposals to considerable lengths, though the impartial observer does not always find it easy to follow such advocacy, because operating districts, or divisions, where steam and electric traction are used on a closely comparable basis do not exist. Thus when Mr. S. B. Warder, Chief Officer, Electrical Engineering, the Railway Executive, in presenting a paper on "Electric Traction Prospects for British Railways," to the Institution of Locomotive Engineers last month, opened by saying that in his opinion the prospects to-day were economically excellent, though politically bad, due to the present Government restriction on capital expenditure, he drew from certain protagonists of steam the retort that if one-quarter of the capital needed for extensive main line electrification were to be spent in providing really up-to-date steam locomotives, and servicing facilities—such, for example, as those on the Norfolk and Western Railroad, in America—an operating result at least equal to that from electrification could be obtained. We have used the word "protagonist," for there would still seem to be some ranged irrevocably on one side or the other. So far as British Railways are concerned, however, the fact that responsibility for both mechanical and electrical engineering is now vested in a single member of the Railway Executive goes a long way to ensure that each project as it comes forward will be considered impartially.

British experience with electric traction on any scale is so far, of course, limited to the lines of the former Southern Railway. Conditions there were very favourable to its adoption, with many London terminal stations, a plethora of alternative routes, and beyond the suburban area a pleasant range of attractive seaside towns, all within 90 or 100 minutes' running of London. Goods traffic is not heavy, and can be run mostly during the night. As each successive section was electrified the benefits of the initial works were more fully realised as more and more steam trains were eliminated from the inner areas, and in 1947 the Southern Railway announced its intention to abolish steam altogether on the Eastern and Central sections by electrifying a further 284 route-miles. A considerable part of Mr. Warder's paper was devoted to a comparison of steam and electric operating statistics on the Southern Region, but while one would agree that the electric data is very impressive and is a lasting tribute to the foresight and drive of the late Sir Herbert Walker in pressing forward one electrification scheme after another, we feel that to compare it with aggregate steam results on the Southern is hardly fair. A high proportion of the steam locomotive stud is over forty years old; indeed, only 20 per cent of it is less than twenty-one years old. This is due naturally to the slowing up of new construction after 1930, when the longer-distance electrification schemes were in hand. Except on certain express routes steam locomotives are now used on less remunerative services, and in many cases engines of high capacity are employed on very light duties. Utilisation is governed by the timetables rather than the availability of locomotives themselves. In laying operating statistics of such steam workings against those of the electric services one is not comparing like for like. It is, in fact, very doubtful if one is ever likely to come across two regions, or divisions, between which a really fair comparison could be made of modern steam and modern electric haulage.

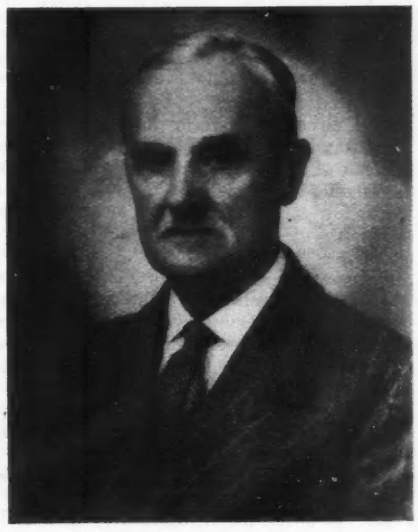
The present economic position renders the prospects for electric traction in Great Britain fluid, to say the least of it. Quite apart from the capital cost of rolling stock and other purely railway equipment there is the question of power supply, to which we have already referred. By the time power is available and money is forthcoming the coal-fired gas turbine may have been so sufficiently developed as to provide an attractive alternative. On the northern lines, too, if the advantages of electrification in providing for increased density of traffic are to be exploited to the full, further expenditure would be necessary to equip freight rolling stock with continuous brakes and automatic couplers. Without such equipment goods trains would not be able to run at higher speeds, and there are too many on the lines for them to be kept clear of the "electrics," as they are now on the Southern. The factor of track maintenance must also feature in the discussion, and although the undoubted increase in costs on the Southern could be attributed in part to the greater number of trains run since electrification, the actual cost of maintenance per train-mile under steam or electric traction is a factor to bear in mind with any future project. Nor can improved amenities of travel be claimed with certainty for electric traction in this country. For against the absence of smoke and dirt, must be set, on the Southern at any rate, the noise from roaring rails, and the vibration, which all too often is so severe as to make reading difficult and writing impossible. In any future main line electrification scheme those nuisances would certainly not be tolerated in long-distance journeys where many travellers use the time to attend to business affairs.

Obituary

OSWALD WANS

As briefly announced in our columns last week, Mr. Oswald Wans died on February 2nd, at the Manor House, Wellingore, at the age of seventy-one. With his death, the oil engine industry has lost one of its pioneers, for Mr. Wans was associated with the development of the oil engine in the early part of the century. When he retired in 1949 he had seen the original Hornsby hot-bulb power unit develop into the modern high-speed compression oil engine, which is now universally accepted for stationary, portable or marine power requirements.

Oswald Wans, who was born on November 17, 1879, received his education at Dulwich College and served an apprenticeship at



OSWALD WANS

Bryan Donkin and Co., Ltd. Following this he added to his engineering experience by service with a number of firms, including Sturtevant Engineering Company, Ltd., Simms Manufacturing Company, Burns and Co., and John I. Thornycroft, Ltd., before joining Ruston, Proctor and Co., Ltd., in 1910. Mr. Wans, who was a strong supporter of the Ackroyd-Stuart oil engine, gave the third Ackroyd-Stuart Lecture in 1931, and never subscribed to the adoption of the term "diesel" for a compression-ignition engine. One of his early tasks was to eliminate the undesirable starting features of the hot-bulb engine and from his designs the cold-starting airless injection engine was established. Another development in which he was interested was the high-compression engine, and he was successful in raising the

compression pressure from 280 lb to 500 lb per square inch within a short period of time. In his early days research work was carried out on the test beds, and Mr. Wans foresaw the necessity for a permanent experimental department, and the idea eventually led to the forming of the British Internal Combustion Engine Research Association, of which Mr. Wans was Chairman of Council from 1945 to 1948.

In 1918 Mr. Wans was appointed technical manager of the company, and in that year patented a duplex fuel pump and atomiser for using tar oils. He next turned his attention to developing the vertical oil engine and, following upon successful tests, a range of larger-powered vertical engines was added to the company's products. Mr. Wans appreciated the economic possibilities of the oil engine as a propulsion unit in fishing vessels and, after the first successful application, gradually raised the power of the engines supplied for marine purposes. Over a period of time engines of 2400 b.h.p. were eventually designed, built and installed, and Mr. Wans looked ahead to the possible adoption of the multi-engine principle with two or four engines geared to one shaft. He wrote a number of papers upon the subject of marine oil engines and they included "Design and Manufacture of Marine Auxiliary Engines," "Small Marine Diesel Engines," and "Oil Engine Trawlers."

After witnessing tests in Switzerland, Mr. Wans was convinced of the possibilities of pressure charging and designed a system for Ruston engines. Another improvement in engine economy which Mr. Wans advocated, and which was adopted, was the chain drive from the crankshaft to the camshaft. To-day, the efficiency of the oil-operated reverse reduction gear is accepted without question and justifies the courage of Mr. Wans in advocating this method when many were prejudiced against it. Mr. Wans was promoted to chief engineer in 1930 and the following years saw the production at Lincoln of narrow-gauge locomotives and of the flameproof mine locomotive, and Mr. Wans felt confident that the latter was the solution of the underground haulage problems.

Seven years after becoming chief engineer Mr. Wans was appointed technical director of the company, a post which he relinquished in 1949. He early appreciated the promise of the gas turbine as a prime mover for industrial and marine work, and was instrumental in inaugurating the gas turbine section at Lincoln. Under his guidance the first open-cycle machine was built and started on a series of tests in the firm's own power station.

Mr. Wans travelled extensively on behalf of Ruston and Hornsby, Ltd. He was a member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers, and of the Institute of Marine Engineers, and contributed a number of papers, which have appeared in the "Transactions" of those and other institutions.

WILLIAM JOHN TENNANT

We regret to announce the death of Mr. W. J. Tennant, which occurred at Amersham, Bucks, on February 8th, at the age of eighty-five. The greater part of his career was spent as a chartered patent agent with the firm of Boult, Wade and Tennant.

The son of a distinguished railway engineer, William John Tennant was born on March 19, 1865, and commenced his engineering training with Stanley Hall and Co. as a junior draughtsman. His technical training was obtained at the Birkbeck Institute and at the Finsbury Technical College, where he was awarded the Honours Silver Medal in Mechanical Engineering of the City and Guilds Institute. After gaining some commercial experience, Mr. Tennant joined the staff of J. H. Johnson and Co. as a technical assistant, and for a time lectured on steam and applied mechanics to the engineering pupils of one of the railway companies. After some eight years he took up the position of assistant engineer with Haseltine Lake and Co., with whom he remained until 1894. In that year he became chief of the technical staff of Boult and Wade, chartered patent agents, and was made a partner of the firm, when the style was altered to Boult, Wade and Kilburn in 1898. At a later reconstitution of the partnership the title of the firm became Boult, Wade and Tennant, and Mr. Tennant remained in active practice until 1939.

Apart from his professional duties, Mr. Tennant was an active member of several technical societies. He held various offices in the Institution of Mechanical Engineers, was Vice-President in 1930 of the Institution of Automobile Engineers, and also served as President and as a Member of the Council of the Newcomen Society. Mr. Tennant was a life member of the Royal Institution and was very interested from 1886 onwards in the Junior Institution of Engineers, of which he became in turn a Member of Council, Chairman, and in 1933, the jubilee year, President. He was a Past-President of the Chartered Institute of Patent Agents. Mr. Tennant often wrote upon engineering subjects, and was the author of a small handbook on "The Slide Valve" and a larger volume on "The Compound Engine"; he also contributed several articles to the technical Press.

SIR ALLAN GORDON-SMITH, K.B.E., D.L.

It is with great regret that we record the death, at the age of seventy, of Sir Allan Gordon-Smith, K.B.E., D.L., the founder of the clock and watch and motor accessory manufacturing business which bears his name. Sir Allan was born in 1881, and after being educated at Christ's College, Finchley, he spent some time in Switzerland, studying the methods of manufacture of watches and similar mechanisms. Returning to England, he joined his father at the Smith business at 9, Strand, London, and at the age of twenty-four assumed its management.

Impressed by the developments of the motor-car, he set to work on the design and production of a speedometer, and in 1914 formed a public company for their manufacture. The outbreak of World War I led to a great expansion of Sir Allan's activities, and he acquired the Cricklewood works for the manufacture of all kinds of aviation instruments, fuses, revolution counters, &c., in large quantities.

In 1919 the company was closely associated with the developments which came with the standardisation of speedometers and similar instruments as normal fittings on cars, and its activities were widened to include gauges of many kinds and other equipment.

The clockmaking activities of the firm increased in 1928, when, in addition to motor-car clocks, the manufacture of domestic clocks and lever escapements was undertaken. Later, the production of synchronous electric clocks also became a large part of the output of the Smith organisation. With these developments Sir Allan achieved his long-desired aim of producing entirely British clocks in large quantities.

The outbreak of the Second World War brought even greater responsibility to Sir Allan. His factories turned at once to the production of enormous numbers of mechanisms for the British and Allied Forces, and he himself became Controller of Construction and Regional Services to the Ministry of Aircraft Production, a position which he occupied from 1941 until 1944, when he rejoined his firm. He was also a member of the Aircraft Supply Council from 1943 onwards, and did much other advisory work. He was knighted in 1939 and in 1941 appointed K.B.E. Sir Allan was also Chairman of the National College of Horology and took a keen interest in the training of young horologists, founding a training school for this purpose as an adjunct to his firm.

Under his guidance the Smith organisation has greatly widened its activities during recent years, acquiring factories at Cheltenham for the production of watches and precision clocks; Carfin, Scotland, for the manufacture of alarm clocks; and South Wales, where a popularly priced model of watch is made.

Sir Allan was a Freeman of the City of London, a member of the Livery of the Clockmakers' Company, a Fellow of the British Horological Institute, a Fellow of the Royal Society of Arts, President of the British Clock Manufacturers' Association, and Fellow of the National Jewellers' Association. In addition, he was associated with many other activities of the horological industry.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PROPOSED TRANSPORT MUSEUM

Sir,—The decision of the British Transport Commission to agree in principle to the establishment of a permanent transport museum at Nine Elms prompts me to refer to my letter which was published in your columns on October 14, 1949.

In this I put forward a plea that one of the Churchward 4–6–0 express engines should be preserved for posterity.

Both the four-cylinder and two-cylinder classes are rapidly dwindling in numbers, although several of these machines, now forty years old, are still performing first-class service.

Churchward's work on boilers is well known, but his name will ever be associated with his pioneer work on cylinder proportions, long-lap, long-travel piston valves with well-designed steam and exhaust passages and his jumper blast-pipe. His work surely forms the basis of all that is best in present-day British locomotive practice, high-degree superheat excepted.

John Fox, M.I.Mech.E.

Hove, Sussex, January 30th.

Increased Subscription Rate for The Engineer

The costs of producing The Engineer have mounted sharply recently, notably—but by no means wholly—in consequence of increases in the price of paper. Those costs show a tendency to rise still further and, unfortunately, over most of them we can exercise little or no control. In these circumstances and beginning with our issue of March 2nd, the price of The Engineer will be 2s. per copy and the postal subscription rate, as from the same date, will be £5 10s. per annum.

Industrial Design and Machine Design

THE INSTITUTION OF MECHANICAL ENGINEERS

No. II—(*Continued from page 197, February 9th*)

FURTHER abstracts from the discussion of Mr. H. G. Conway's paper "Industrial Design and its Relation to Machine Design" are given herewith.

Mr. C. J. Whitcombe said that, although a great deal had been said in the discussion about industrial design, very little had been said about why industrial design was wanted for engineers. There were really four different types of product. There were those which were purely æsthetic, those in which the functional and the æsthetic appeared to go together, those which were purely functional and those (with which engineers were often concerned) where it did not seem to matter.

There was no need to bother about the first type, but in the second the motor-car was probably the best example. The engineer had to design the engine and the stylist had to add some appearance to the body. Of the purely functional type, the aircraft was undoubtedly the leading example; appearance was considered not because of what it was going to look like when finished but because the appearance affected the manner in which the aircraft functioned. In the last category—products in which it did not seem to matter—he would almost include machine tools, but at any rate one might include such things as pumps, pipes, sewage equipment and so on. However, even in this last category he had a feeling that it did matter what the products looked like. So far in the discussion there had been consideration only of those things in which the appearance should have a certain form of beauty. There were, however, certain engineers making machines who felt that if those machines were too beautiful the customer would not buy them. There was actually one firm which had advertised its machines as having a "rugged" appearance.

Mr. John Barnes felt that the paper rather gave the impression that the industrial design movement had started in America, but it should be borne in mind that Europe had been very conscious of industrial design for many years. As far back as 1915 there had been started in this country the Design in Industries Association, which was essentially concerned with the promotion of better design and which, he believed, gave consultative advice to manufacturers who wished to have it. The most important organisation in connection with industrial design had been the Bauhaus in Germany. It had been a unique organisation for training and producing industrial designers and the curriculum had been to some extent adopted in this country and was now being used. The Bauhaus no longer existed, although some of its members had gone to America and had a school in Chicago. The point that he wanted to stress was that for many years there had been awareness of industrial design in this country, and America was not responsible for the idea. The Royal College of Art now had a course in industrial designing and intended to give to successful candidates a degree in industrial design which would put them on the professional basis which they deserved.

Mr. A. B. Cooper, said that he would focus his remarks on the problem of styling designs in a medium-sized engineering firm, making a wide variety of automatic machinery. He was convinced that better work was done by people using good-looking machines and tools in the accepted sense of the terms and working in well-proportioned buildings surrounded by well-balanced colours. However, the real justification of styling was that, while the specification of a machine was unquestionably of the first importance, it would be more compelling to the buyer if it also looked as though it was good. That argument justified a little extra cost for styling, though in his experience, the buyer would not pay much for it. It did not, of course, follow that the extra cost would occur and it was often the reverse.

Improved appearance could be achieved by introducing into the training of mechanical designers some instruction and practice in artistic analysis. This training must not be too free or too extended as it must be realised that it constituted a very secondary part of engineering training. It must, however, awaken a consciousness of the desirability of good appearance so that right from the beginning of a design the consideration of ultimate form took its place with function, strength, performance and any other matters when arriving at the machine lay-out and selection of mechanisms to be employed.

One of the problems was to find time in the training period of an engineer to introduce this aspect in his work and it seemed likely that it would have to be done fairly late when he had a good general grounding in the technical side of his profession and had decided to specialise in design. It then seemed likely that he would need to take at least a year in a suitable curriculum and perhaps another year under the influence of his artistic instructors while at the same time working in his engineering capacity.

The Problems of Small Firms

Mr. P. J. Packman, observed that so far most of the emphasis in the discussion had been on industrial designers, but he wanted to speak as a chief mechanical designer and as the managing director of a comparatively small engineering firm, in which he was confronted with two problems. The first was how to make the best choice of men and the second was how to see that the firm's money was spent wisely. The challenge that seemed to emerge from the paper was in what circumstances should the services of an industrial designer be engaged?

He felt that there was no simple answer to the question. It depended on four things: first, the quality of the designer already employed; secondly, the type of work which the firm was doing; thirdly, the degree of maturity to which the article had advanced and, fourthly, the materials and tooling available.

Mr. E. G. M. Wilkes, said that he spoke as an industrial designer, but since he was in the motor industry he had to put up with being called a stylist, a term which had originated in America and had come to this country very largely through the motor industry. He wanted to stress the importance of honesty in design. Some of the worst examples of dishonesty in design were to be found in American motor-cars. In America, where they had a very great knowledge of shapes, textures, materials and colours, the stylist—instead of aiming at the same goal as the engineer—was so concerned with appearance that he had enclosed himself in a little world of his own and had made appearance a thing on its own, completely divorced from the original objective of the machine. That was a danger that must be guarded against in this country.

Mr. Denis L. Johnston said that the paper dealt very well with the appreciation of industrial design, but it did not really tackle the practice of industrial design. He was sure that a great many engineers designed well instinctively and not by principle. Perhaps some of the most successful industrial designers had been those having a training in architecture, and the reason for their success might very well be that in architecture the training started with the general and worked down to the particular, whereas in engineering the training usually started with the details and worked up to the general.

He would like to hear a great deal more said about the principles to be followed in industrial design. There was the question of scale and scaling in a range of products. An example of this was in Fig. 10 in the paper, which showed a range of compressors. Those compressors followed a logarithmic scale, each being a certain percentage larger than the one before. He was glad to say that the engineering term for this had recently been raised to the level of a British Standard.

Functional Design

Mr. Firth observed that the present discussion showed that, as in all discussions on æsthetics, one could not get very far before the remark, "It all depends what you mean by . . . ." cropped up. As a practising and a practical engineer, he felt that many of the references in the paper were to fashion rather than to design in a scientific sense. In Fig. 11, in the paper, the latest version of the petrol pump could, from its shape, quite well be a modern refrigerator or a washing machine.

The point he wanted to make was that there was a vast field of engineering, not mentioned by the author, in which "styling," in the sense used in the paper was not possible, but in which the application of scientific design, together with a few simple principles, could produce highly satisfactory results to the engineer and often an austere beauty to the general eye. Shapes produced by the correct application of scientific design were invariably satisfying to the engineer and often to the more general onlooker.

To illustrate his point, Mr. Firth referred to a number of slides. The first showed a portal frame made possible by the conjoint development of mathematical theory and developments in welding. There was no question of "styling" here: it was right structurally and mechanically and from a manufacturing point of view, or it was wrong. The second slide showed a simple storage tank, which had been designed on the "membrane theory" of pipe design, which made possible larger spans with thinner plates, besides making possible a much cleaner design than the conventional rolled steel joist supports. There was a considerable improvement from the visual point of view, and yet the whole thing was determined by scientific principles rather than by any conscious attempt at style.

The third slide showed a process tank, where an attempt had been made to strut design for the legs in order to get away from the rather ugly principle of using standard

rolled steel joists. The solution was satisfactory to the eye and economical in its use of material. Another slide showed a Kaplan turbine, which had been designed on scientific principles. The shape was closely determined by the conditions of flow. Fashion or styling had no place here but who could deny its beauty?

Mr. E. M. O'R Dickey, Staff Inspector for Art, Ministry of Education, said that his colleague, Dr. Abbott, and himself had devoted quite a lot of time to trying to promote in art schools and technical colleges a growing interest in the very interesting subject discussed in the paper. As an indication of what was being done he mentioned that the Central School of Art and Crafts, in Southampton Row, London, had taken up the subject at the end of the war and had been doing very worthwhile work. The Birmingham College of Art and the Leicester College of Art had been engaged in it for some time. The students at the Central School of Art and Crafts went to the Northampton Polytechnic to learn the use of machine tools and to the Borough Polytechnic to learn about the technicalities of plastics. There was, therefore, at least one scheme in which art and technical institutions were not at variance.

Professor R. D. Russell, Royal College of Art, gave a brief description of the work of the Royal College of Art school for training designers in wood, metals and plastics. The work had begun just over two years ago and had been devoted exclusively to furniture, but an attempt was now being made to arrange a syllabus for an engineering course.

He agreed with his brother, Mr. Gordon Russell, that engineers were apt to take themselves too lightly and to underestimate their capacity. The tradition of engineering design in this country some time ago had been a splendid one. The design of locomotives, ships, machine tools and equipment of all sorts had been really first-rate. He thought that tradition had lapsed a bit now, and that the reason it had done so was probably because engineers relied too much upon imported stylists; they did not allow themselves sufficient scope and relied too much upon other experts.

His school was attempting to train from six to twelve students a year in engineering design. The principle on which the school was working was not to take students from the art schools and attempt to turn them into designers with a certain limited experience of engineering but rather to take from industry trained engineers and give them a short course in design on a fairly broad plane and not to specialise too much. The school had the advantage of having many other things going on at the same time—painting, sculpture, typography and textile design—so that students could get into touch with the humanities of design on a fairly wide front.

That was the experiment which the school was discussing with Mr. Cooper at the moment and he very much hoped that something would come of it. It was hoped to give to trained engineers a reasonable course, which would open their minds to the possibilities of design in, perhaps, a year.

A Dynamic Braking and Motor Control System for A.C. Winders

WE have received some particulars of an interesting system, which has been devised by the General Electric Company, Ltd., for controlling a.c. mine winders driven by slipring induction motors arranged for dynamic braking. The method of control is designed to allow the maximum acceleration or retardation at all loads, without depending on timing mechanisms or current limiting apparatus to ensure safety of the hoist. We learn that the scheme is being used with four 4200 h.p. winders, which are being installed for the Free State Development and Investment Corporation of South Africa.

Before considering the new control system it may be helpful to recall the operating conditions of a slipring induction motor driving a mine winder. Briefly, the stator of the motor is connected to a three-phase a.c. supply through three-pole reversing contactors to allow forward or reverse winding. The current and torque are limited by a variable resistance in the rotor circuit. For dynamic braking a double-pole contactor applies direct current between two phase terminals of the stator, while the rotor resistance is used as a variable load.

During motoring the control of the rotor resistance which protects the motor against excessive torque and current, presents no particular difficulty; the new system of control, however, provides that the value of the resistance shall always be such as to give the most economical operation. Dynamic braking, on the other hand, gives rise to certain problems: one particular difficulty is to reconcile some apparently conflicting conditions in the relationship between the strength of the d.c. excitation of the stator and the value of rotor resistance. The problem has been solved in such a manner that d.c. excitation is automatically restricted at the low speeds required for rope and shaft inspection without forfeiting the braking power normally needed at such speeds, when for instance, a loaded or empty hoist is approaching the decking position. This reduction of excitation is necessary because the reduced ventilation on a prolonged run at low speed would otherwise lead to excessive heating of the machine. The control of both d.c. excitation and rotor resistance has been combined so that the response to the driver's lever is quite definite. In no case can torque decrease when it should increase with increasing travel of the lever, and vice versa. Whether

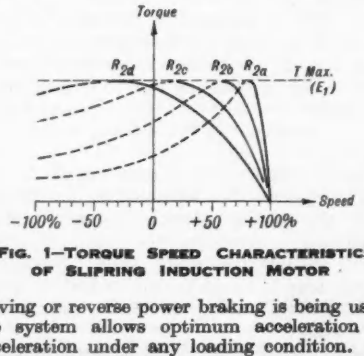


FIG. 1—TORQUE SPEED CHARACTERISTICS OF SLIPRING INDUCTION MOTOR

driving or reverse power braking is being used, the system allows optimum acceleration or deceleration under any loading condition.

To understand the operation of the system of control it is necessary to recall the torque/speed characteristics of the induction motor. A typical family of torque/speed curves is given in Fig. 1, for a slipring induction motor with constant applied a.c. voltage and with constant, but different, rotor resistances increasing in the order R_{2a}, R_{2b}, &c. It will be seen that the maximum torque is always the same and does not vary with the different resistances, which serve only to determine the slip and hence the speed, of the motor, at which this maximum occurs. Each curve is drawn in full and dotted lines: the plain portion is the stable part; the dotted portion the unstable part, which must be avoided in operation because here the torque decreases as the speed falls.

From an analysis of the behaviour of a slipring machine two things can be shown. First, for every value of d.c. excitation current applied for dynamic braking there is a definite ratio between rotor resistance and speed, which will give a constant and optimum torque, which is independent of speed. Secondly, the torque of the machine when operating as a motor will be constant and independent of the speed if, during motoring, the rotor resistance is made to vary as the slip.

These two results, translated into practical form, provide the solution of the problem of controlling the motor, both when it is driving and when dynamic braking is being applied. In the latter case the rotor resistance is automatically controlled so as to give maximum braking torque for any given value of excitation. This condition is satisfied by automatically maintaining the correct relationship between the d.c. excitation current applied to the stator and the optimum ratio of rotor resistance to speed. In these circumstances there is a minimum dissipation of energy in the form of heat. Furthermore, operation at, or near, maximum torque minimises the effect of the relatively coarse steps of resistance in contactor-controlled grid resistors, or of the variation of resistivity of the fluid in liquid controllers. Braking torque varies very little between consecutive resistance steps, but is steadily controllable by the d.c. excitation, which is varied smoothly so as to give very fine and accurate control of braking.

When the motor is driving, or when reverse power braking is employed, it is necessary only to keep the rotor resistance at a fixed ratio to the slip and to provide means for controlling the value of this ratio. The motor will then run up with constant torque independently of speed and without the need to introduce time delay or current limiting devices, the value of the torque bearing a definite relationship to the position of the driver's control lever.

Operation of the Control Scheme

The practical application of the control scheme is shown in Fig. 2, which, for simplicity, is drawn as a single line diagram, with double or treble dashes indicating two- or three-phase circuits, respectively.

The driver has two control levers: the one on his left operates the mechanical brakes; that on his right actuates the electrical control scheme. The right-hand lever works in an "h" gate, the left-hand side of which is double-ended and is used for forward and reverse winding and for reverse power braking. The right-hand side of the gate is single-ended and is used to apply dynamic braking. In the central or neutral position the lever is vertical and all power is switched off. In Fig. 2 the control lever, seen on the right, is shown engaged through a quadrant to a vertical rack and control bar, which performs the three main functions of operating: (*a*) the contactors for energising the motor and auxiliary gear (centre); (*b*) a variable ratio transformer, *VT* (bottom) and (*c*) the d.c. excitation control for dynamic braking (top).

Driving

When the control lever is moved to the left it connects the stator of the winder motor to the a.c. supply. At the same time the sliprings of a small 3/2-phase control generator are connected to a low voltage a.c. supply provided by an auxiliary transformer seen at the top of the diagram.

The control generator has a two-phase wound stator and a three-phase wound rotor and is mechanically coupled to the winder motor. The voltage induced in the two-phase stator will be proportional to the slip of the winder motor. This induced voltage energises the voltage transformer *VT*, the tapping ratio of which is altered by the operation of the main control lever. The tapped voltage feeds one

of the control coils, *RR*, of an electro-magnetically operated oil servo-mechanism through a variable resistance, r_1. When the "raise resistance" (*RR*) coil is energised the servo-mechanism tends to raise the main rotor resistance R_2 and the resistance r_1, which are controlled in unison. Whenever the valve is under the influence of its own weight only

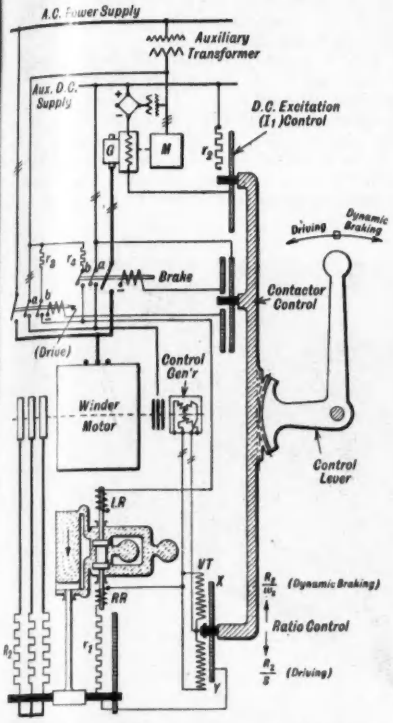
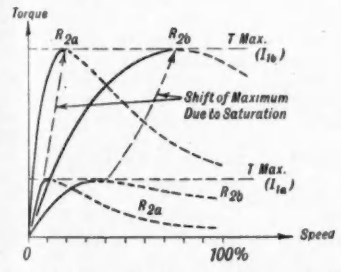


FIG. 2—SIMPLIFIED DIAGRAM OF CONTROL SCHEME

it will also raise both resistances to their maximum value, so that when all control excitation is off the rotor resistance R_2 will be at its maximum.

The other control coil, *LR*, is fed with a constant a.c. voltage from the auxiliary transformer, thus producing a constant pull on the servo-valve, tending to lower the resistances R_2 and r_1. In operation the piston will come to rest in the position at which the pulls of the



Curves for constant excitation and resistance R_2

FIG. 3—DYNAMIC BRAKING CHARACTERISTICS

two opposing coils *LR* and *RR* are equal. But since the current in coil *LR* is constant, the current in the coil *RR* at equilibrium must always be the same; that is, the resistance r_1 must be proportional to the induced voltage of the control generator, or proportional to the slip. By a suitable choice of resistances in the circuit the rotor resistance R_2 will also be proportional to the slip. This, it will be remembered, is the condition required for constant driving torque independent of motor speed.

When starting a wind, the control lever is in the neutral position, the resistance R_2 is all in and the voltage induced in the control generator is a maximum. Immediately the control lever is moved full voltage is applied to the *RR* coil, which accordingly holds the rotor resistance at its highest value. Further movement of the lever alters the tapping on the voltage transformer *VT*, and reduces the voltage applied to the coil *RR*, whereupon the coil *LR* takes charge and lowers the resistance R_2 so as to correspond to the torque represented by the position of the lever. This process continues until the necessary starting torque is reached and the motor begins to revolve. Thereafter the rotor resistance decreases automatically, due to the decrease in the induced voltage of the control generator with increasing speed, until the voltage reaches its minimum value and the motor approaches synchronous speed.

BRAKING

The family of torque/speed curves for different values of rotor resistance at constant d.c. excitation is shown in Fig. 3. Here, again, it is important that the unstable portions, shown dotted, should be avoided.

To apply dynamic braking the control lever is moved to the right (Fig. 2) thus connecting the stator of the winder motor to the d.c. generator of the motor-generator set. The field current of the generator is directly controlled by the driver's lever through the resistance r_2. The control generator is also excited with direct current through two of its sliprings and therefore acts as an ordinary d.c. excited alternator, the voltage at the stator terminals being proportional to the speed of the winder motor. The *RR* coil is energised by this voltage through the variable transformer *VT*, which is controlled by the driver's lever as before, the tapping ratio varying with the actual d.c. applied to the winder motor so as to satisfy the optimum relationship between the current and the ratio of rotor resistance and speed, as described below.

If the driver decides to apply dynamic braking when the motor is running at full speed, he must first move his control lever back to the neutral position, thereby inserting resistance in the rotor circuit. Further movement of the lever into the dynamic braking position will cause the contactors to operate and apply direct current to the stator of the driving motor and to the three-phase wound rotor of the control generator. If the resistances R_2 and r_1 are all in, the current in the *RR* coil will not be strong enough to overcome the pull of the *LR* coil, which will consequently operate so as to reduce the resistance in the rotor circuit. The simultaneous reduction of resistance r_1 will then increase the current in the *RR* coil until it is of such a value as to balance the pull of the *LR* coil, when the movement will cease. The rotor resistance will then be at its optimum value in relation to the d.c. excitation and the momentary speed of the winder motor. The falling speed of the winder motor, due to the braking effort, will now reduce the voltage applied to the *RR* coil and the *LR* coil will take control and lower resistance so as to maintain the desired braking effort independently of speed.

Any desired braking effort up to the maximum is obtainable by moving the driver's lever, its position being always a measure of the braking torque applied. The control system automatically holds the rotor resistance at its optimum value, thus ensuring stable operation, with the lowest possible current in both the stator and rotor windings and therefore minimum losses and heating.

An important characteristic of the system of control is that, whether the motor is winding or braking, the maximum permissible torque can never be exceeded no matter how the lever is operated. The exact figure is arranged to suit the user and does not normally exceed two to two-and-a-half times full load torque.

Mobile Drum Factory

BEFORE the official opening of the second National Packaging Exhibition we were able to inspect the Van Leer mobile factory in operation in the Empire Hall, Olympia. The enterprise, which owes its inception to Mr. Bernard Van Leer, has been developed to satisfy a special set of circumstances. These are related to conditions where speed of initial output is imperative, and where incidental and seasonal demands for large quantities of drums are required at a point, the location of which may be changed within a short period of time, so that a permanent factory would not be a reasonable proposition. The problem has been solved by building a mobile drum factory consisting of a number of road vehicles, which, when grouped together, form a complete production unit.

The necessary machines with their electrical equipment, compressed air and water supplies, are mounted on these vehicles, while separate transport is provided for a diesel-driven electrical generating plant, fuel oil, water, steel stock and ancillary materials. Special office, living, sleeping, restaurant and theatre cars complete the group. The factory, which has been brought to London at the request of British industry and the Government authorities, was designed for use in Africa, the Middle East and the Far East, and has some military value for use in bomb-damaged areas and at other points in the supply line.

The demonstration we witnessed began with the trailers carrying the factory machines, lined up at a fixed distance apart and the crew commenced to bridge the gap with portable girders and covering boards, to erect roof trusses and purlins, fix tarpaulin covers and to start up the diesel generator. With power available the various machines were set in motion and the drum making operations began. The whole sequence, from starting up to the completion of the first batch of drums, occupied eighteen minutes.

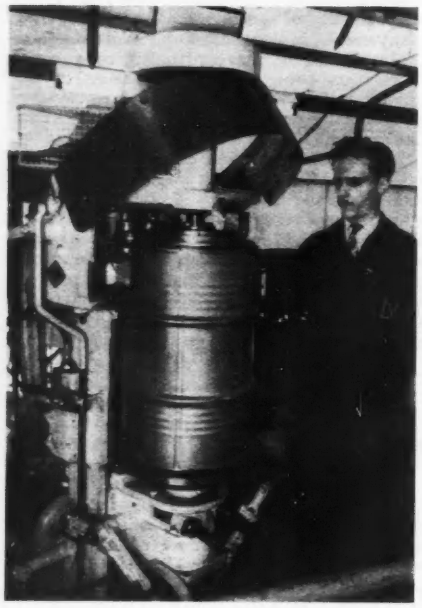
The factory was tooled up to produce 10-gallon drums for Shell products and the sequence of operations started with sheets of steel stock of No. 24 gauge being cut to size in a guillotine shear, after which the edges and faces were buffed in preparation for welding; a set of rolls transformed the sheet into an open-ended

ROLLING-IN STRENGTHENING CORRUGATIONS

cylinder, and this was spot welded before passing to a water-cooled continuous 100kVA resistance seam welder with ignition valve control. The welded cylinder next passed along a gravity conveyor to an expanding machine,

where in two operations corrugated rolling hoops were formed and which ensured that the cylinder was a true circle. Each end was turned over in a flanging machine in preparation for fitting the end covers, and then four additional shallow strengthening corrugations were rolled in at each end, as shown in our illustration on page 229. At this point pressed end plates with ¾in and 2in diameter "Tri-sure" flanges already mounted were fitted in the machine, shown in our illustration, and the drum passed through a double sealing machine to a pressure-tight joint.

This last operation completed the manufacturing line and the drums were transferred to the finishing line by gravity conveyor. Each drum was subjected to a pressure test; air at 7 lb per square inch was admitted to the drum and the seams covered with a soap solution to detect any leakage. After drying, the drums were placed on a turntable in a paint spraying booth, spray painted and subsequently dried by being passed through an electric radiant



FITTING DRUM ENDS

heating oven on an endless conveyor.

The ¾in flange was fitted with a cap seal, which was crimped on by a special tool and the drum was then ready for filling. This size of drum, it is understood, can be produced at the rate of 1000 every eight hours, and the plant is manned by a crew of twenty men, ten of whom operate the machines.

The power for the factory is supplied by a diesel engine which develops 150 b.h.p. at 1000 r.p.m. and drives two three-phase, 50-cycle generators in tandem, one of 125kVA for welding purposes and the other, rated at 75kVA, supplies the motors driving the machines and provides for the lighting. Certain ancillary equipment is associated with the machine section to make the factory a self-supporting unit.

TRAINING FOR THE AIRCRAFT INDUSTRY.—An illustrated brochure has been issued by the Society of British Aircraft Constructors describing the apprenticeship training policy of the aircraft industry. The brochure describes how a number of firms in the industry are arranging an exchange scheme to enable trainees to work in specialist establishments as part of the standard apprentice training procedure. It shows also how boys of different ages and educational accomplishment can find a place in the design and construction of aircraft and engines, and mentions the opportunities which exist for specialisation and working abroad. Schemes for certificate and degree courses and for university scholarships are given, with details of the S.B.A.C. educational grants which are made to boys who would not otherwise be able to take up a full technical training course.

An Underground Diesel Locomotive

A NUMBER of interesting features have been introduced in a 75 h.p. mine locomotive, which has recently been added to the range of underground locomotives made by Ruston and Hornsby, Ltd., of Lincoln. This new locomotive can be used in either gassy or naked flame mines and, as can be seen from the photograph reproduced on this page, has a driving position at each end. With these two driving positions the driver is given an unrestricted range of vision in each direction of travel and at the same time he has the maximum amount of protection as no part of his body projects beyond the profile of the locomotive.

The oil pressure required for clutch operation is supplied by a gear pump driven from the gearbox primary shaft. Drive from the engine is taken to an input bevel pinion, which drives the clutch shaft through bevel gears, which can be clutched to the shaft to give either a forward or a reverse motion. The selected clutch transmits the power to the final drive

75 H.P. UNDERGROUND DIESEL LOCOMOTIVE

Control of the vehicle is simple, there being only two levers, one for gear-changing and the other for applying the air brakes. When the driver changes his driving stations he detaches the control levers and takes them with him to the other end of the locomotive.

These locomotives, which weigh 10 tons in working order, can be built for various gauges from 1ft 7⅝in to 3ft 6in, the minimum recommended rail weight being 25/30 lb per yard. They have an overall length of 13ft 10½in and a height of 4ft 11in.

Each locomotive is of unit construction throughout and each unit—engine, gearbox, radiator, &c.—is easily detachable without disturbing other units. There are no working parts under the locomotive and all maintenance and adjustments can be carried out without need for an inspection pit. Other than the main frame, axles and jackshafts, all parts are completely interchangeable from one locomotive to another of the same type, irrespective of the gauge.

The locomotive has a Ruston Mark 4YEL four-cylinder oil engine of 75 b.h.p. at 12-hour rating with a speed range of 500 to 1500 r.p.m. Power is transmitted through a four-speed constant mesh gearbox, having a low-pressure oil-operated cone clutch operating each gear. The four interchangeable, hydraulically operated clutches are of standard pattern and are mounted on the same shaft. The top portion of one of the clutches with the top cover removed can be seen in one of the accompanying illustrations.

shaft through the reduction gears mounted on lay and intermediate shafts.

The final drive shaft is mounted on roller bearings integral with the gearbox and is independent of the jackshaft mounting. All shafts and gears in the gearbox are of high grade nickel chrome steel and are mounted on ball and roller bearings throughout. Lubrication is automatic and a magnetic filter is incorporated in the system.

The makers point out that with this gearbox it is impossible to miss or crash a gear as gear-changing is effected positively by means of a short hand lever working on a quadrant. On selecting a gear, oil is fed from the control body to the clutch shaft and thus to each appropriate clutch.

Forward and reverse direction of travel is selected by engaging the dog clutch between the bevel wheels of the clutch shaft. To facilitate easy engagement a synchro-mesh unit is incorporated.

Haulage Capacities

Gear	Speed (m.p.h.)	Tractive effort (lb.)	Drawbar pull (lb.)	Tons (hauled on straight track)					
				Level	1/200 (0·5 per cent)	1/100 (1 per cent)	1/50 (2 per cent)	1/25 (4 per cent)	1/20 (5 per cent)
1	2·625	5,600	5,400	270	170	122	76	41	32
2	4·0	5,600	5,400	270	170	122	76	41	32
3	6·5	3,680	3,530	235	130	88	51	25	19
4	10·25	2,330	2,180	145	79	52	29	12	8

The haulage capacities of the locomotive in the different gears are shown in the above table.

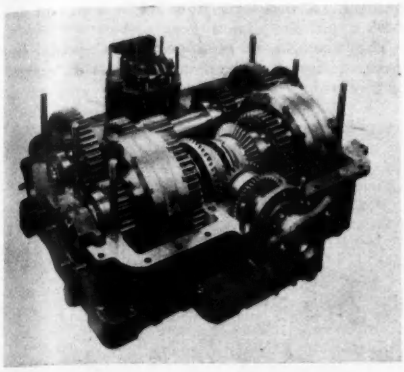
The rail wheel centres are of cast steel with rolled steel tyres shrunk on, the 1ft 7in diameter wheels being pressed on to the axles and keyed. The axles run in bronze journals

fitted in cast steel axleboxes, carried on coil springs and fitted with renewable steel liners on the faces bearing against the horn guides.

Connecting and coupling rods of steel are fitted with oil-lubricated floating bushes, which can be replaced without removing the rods.

Westinghouse straight air brakes are fitted in addition to a hand-operated parking brake, and for man-riding duty train pipe connections can be provided to locomotives of 2ft gauge and over. This brake gear is made in two interchangeable units, each with an operating cylinder, one unit being fitted on each side of the locomotive frame between the rail wheels.

The jackshaft is arranged with a splined drive in the final drive spur-wheel of the gearbox. By removing one jack crank and



GEARBOX WITH TOP COVER REMOVED

one bearing, the jackshaft can be removed sideways, without any other interference with the gearbox. The shaft runs in roller bearings, the housings of which are spigoted into the main frame side plates.

Air-operated sanding gear is arranged for sanding the wheels in either direction of travel.

Buffers and couplings can be arranged to suit individual requirements and if link and pin couplings are used a multi-slot beam is mounted on the ends of the locomotive. Should the fitting of automatic or semi-automatic centre type couplings be specified arrangements are made to recess the shanks of these couplings into the locomotive to reduce overhang to a minimum.

A two element radiator is positioned about midway along the locomotive. Cooling air for this radiator is drawn through the elements by a centrifugal fan and discharged through a vent on the opposite side of the machine. The radiator unit is segregated from the engine compartment to ensure that the power unit is not exposed to any damage which may be caused when working the locomotive in dust-laden atmospheres.

Headlamps fitted at each end of the machine are supplied from a dynamo driven from the main engine, no battery being used. The normal method of starting is by low pressure compressed air through the medium of an air starter motor.

Compressed air for starting the engine, operating the brakes, sanding gear and warning device, is supplied by a compressor driven from the engine. This air is stored in a receiver mounted in the locomotive superstructure and the receiver is fitted with a connection so that it can be charged from an external supply if necessary.

An exhaust conditioner fitted to the main locomotive frame effectively removes the irritant constituents of the exhaust before passing them to the atmosphere. The conditioner box is readily accessible for cleaning and inspection and its design is such that it is not possible to draw water back from the conditioner into the engine. When working in gassy mines or explosive areas, flame traps are fitted to the inlet side of the engine and to the exhaust outlet from the conditioner box. A spare exhaust flame trap is provided as standard so that the locomotive can be kept in continuous service.

In the driving stations at each end the controls include a conveniently placed speedometer, appropriate instruments, a fire extinguisher, &c., and above the driver's head a protective extension plate is fitted.

Oil Pipe-Line Transport Vehicles

THE laying of the new oil pipe-line, from Kirkuk to the Eastern Mediterranean shore, which is under construction by George Wimpey and Co., Ltd., for the Iraq Petroleum Company, Ltd., has made necessary the provision of adequate transport for the personnel engaged on the project, from their domestic quarters to the various building sites. To satisfy these requirements the contractors ordered and have recently taken delivery of, a number of vehicles built by Transport Equipment (Thornycroft), Ltd. The equipment supplied included six thirty-seater contractors' buses, five 2000-gallon petrol and oil road tanks, and one heavy breakdown vehicle.

The buses were built on the latest "Trident" normal-control, left-hand drive chassis, with a 13ft 6in wheelbase, and powered by a six-cylinder direct-injection oil engine of 78 b.h.p. The chassis, which is designed to take a maximum gross laden running weight of 12 tons, is of deep-frame section with bolted cross members. Contrary to the usual highway coach requirements, the chassis frame, except for a slight upsweep over the rear axles, is level and so provides the high ground clearance necessary for operation over rough tracks and desert. Under working conditions a bus may sink into soft sand and, to enable the vehicles to be pulled out of such difficult positions, a towing loop has been fitted at the forward end. Semi-elliptic progressive pattern springing is fitted, the brakes are vacuum servo-assisted and hydraulically operated, and the steering, of cam and double roller design, gives a turning circle of 56ft.

A Park Royal thirty-seated front-entrance body with forward facing seats has light, but strong, coachwork, consisting of inside and outside panels of light alloy riveted to steel pillars. There is a continuous louvre along each side and the windows are of the half-drop pattern, additional ventilation being provided by the fitting of six extractor vents in the roof. At the back of the body is a large emergency door and a hinged panel gives access to the drawbar gear and spare wheel.

Brief particulars of the 5·51 litre capacity engine show that it develops a maximum of 78 b.h.p. at 1900 r.p.m., and a maximum torque of 232 lb-ft at 1300 r.p.m. Power is transmitted through a 14in diameter single-plate dry clutch through a gearbox to a fully floating hypoid rear axle.

The road tank vehicles, which we illustrate, incorporate a "Trusty" left-hand drive chassis of 17ft 3in wheelbase, with a turning circle of 70ft and powered by a six-cylinder, direct-injection compression-ignition engine of 100 b.h.p. A specially ventilated all-metal cab ensures comfortable driving conditions. The 2000-gallon welded elliptical tank is of No. 12 gauge mild steel plate, and is divided by two divisions into three compartments of equal capacity, two for oil and one for petrol. Tank fittings are in accordance with the Petroleum Regulations, each compartment has a vacuum and pressure-release valve, and a ladder and walkway provide access to the tank manholes. Housed in the extended front end of the tank is the pump compartment, in which the three 2½in outlets are coupled to a Kitson pump, which delivers 3500 gallons per hour at 350 r.p.m. and is power driven by means of chain take-off. Upward hinging doors to the pump compartment provide protection from the sun during pumping operations. A "Brodie-Kent" air eliminator and flow meter is coupled to each outlet, one meter being calibrated for petrol and two for oil. For filling the tank from an external source a 2½in outside suction connection is provided.

For the heavy breakdown vehicle a short wheelbase "Trusty" chassis was selected, with special cooling in the form of a large radiator area and a six-bladed fan. This additional cooling was considered necessary to enable the vehicle to operate in high ambient temperatures and under desert conditions. The Neville all-steel cab is well ventilated, has an insulated roof and a rear window to facilitate winch operation from the cab. Immediately behind the cab is a short body which accommodates the breakdown equipment, and has a ⅛in steel plate floor and three rings on each side for attaching snatch blocks for winch rope operation. There is a Harvey Frost 5-ton manually operated salvage crane and a Darlington 50,000 lb winch deriving its power through a Martin-Harper power take-off fitted to the chassis gearbox. The winch is provided with 250ft of ¾in diameter steel rope which is led underneath the body to a fairlead at the rear. Other items include trailer brake gear, drawbar gear, rear towing hooks, and four telescopic detachable jacks.

2000 GALLON PETROL AND OIL ROAD TANK

International Exhibition in Jerusalem

AN international exhibition, entitled "The Conquest of the Desert," is to be held in the buildings and grounds of the Jerusalem Convention Centre in May, 1952. Its aim is to show the achievements of various nations in their struggle with the desert and to demonstrate their efforts to reclaim wild regions. Exhibits will include those indicating modern methods of finding water in arid zones, irrigation, afforestation and agricultural production and processing. There will also be exhibits relating to communications and transport, town planning and scientific research. The

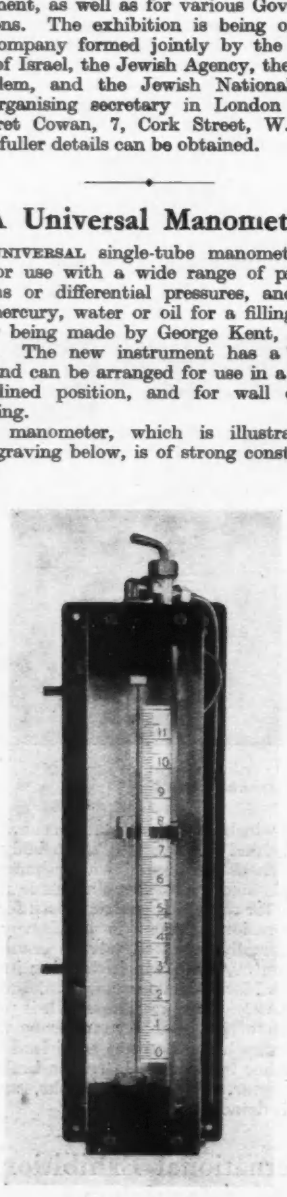
exhibition will be divided into two sections, the first presenting exhibits by different Governments, including Israel, showing their achievements in the conquest of deserts in their own countries or overseas possessions, and the second, including commercial exhibits, by firms which manufacture or export implements used in the conquest of the desert, particularly in the Middle East. Simultaneously with the exhibition, there is to be an international scientific symposium.

The Convention Centre is being erected at the western approaches on grounds situated within the angle formed by the junction of the road to the western suburbs of the city and the road to Tel Aviv. The floor area at the disposal of the exhibition authorities, within the Centre, is 16,000 square metres, and a further 30,000 square metres will be available outdoors for exhibiting heavy agricultural and irrigation equipment, as well as for various Government pavilions. The exhibition is being organised by a company formed jointly by the Government of Israel, the Jewish Agency, the City of Jerusalem, and the Jewish National Fund. The organising secretary in London is Miss Margaret Cowan, 7, Cork Street, W.1, from whom fuller details can be obtained.

A Universal Manometer

A UNIVERSAL single-tube manometer suitable for use with a wide range of pressures, suctions or differential pressures, and which uses mercury, water or oil for a filling liquid, is now being made by George Kent, Ltd., of Luton. The new instrument has a vertical scale and can be arranged for use in a vertical or inclined position, and for wall or flush mounting.

The manometer, which is illustrated in the engraving below, is of strong construction,



A UNIVERSAL MANOMETER

consisting of upper and lower blocks joined by a channel section and incorporating gland units for the glass tube. An accurately machined reservoir for the manometer liquid, which is mounted at the back of the lower block, is held by a single bolt and can be easily adjusted to maintain the reservoir in an upright position if the instrument is inclined. Instruments designed for differential pressure measurement are fitted with up and down stream valves, one equalising valve and an air vent. For suction and pressure instruments only one valve is fitted at the inlet. Adjustable zero setting is provided for the scale.

These manometers are made with scale lengths from 12in to 60in in increments of 12in. Using mercury as the manometer liquid, the maximum scale reading possible is over 800in water gauge. In this range of instruments two inclined positions are standard and they give ratios of 1 : 2 and 1 : 3 of vertical head to scale length. The maximum static working pressure is 150 lb per square inch, whilst the test pressure for the instrument is 300 lb per square inch and the accuracy is stated by the makers to be within 0·1 per cent over the whole range. If required the scales can be calibrated in inches of head of manometer liquid or in units of flow of gas or liquid.

The makers do not recommend that the manometers should be used in the inclined position with water or mercury filling as the meniscus does not then give a very clear reading.

A Pipe Clamp for Welding

A USEFUL clamping device has been developed by Donald Ross and Partners, Ltd., 1–3, Arlington Road, London, N.W.1, to provide a quick and accurate means of positioning and clamping pipe ends ready for butt welding. These clamps are now being made in a range of standard sizes suitable for pipes from 2in to

PIPE WELDING CLAMP

12in diameter. Each clamp can be adjusted for working with pipes from ¼in above or below the specified size for which it is made.

The simple design and the method of operating one of the "Twinner" pipe clamps, as they are known, can be seen in the photograph reproduced on this page. When the two pipe ends to be welded together have been set in line the clamp, which is in the form of two hinged split-rings connected by rollers, is placed in position with one ring on each pipe. A toggle actuated claw mechanism pivotally mounted on the roller at one side of the clamp opening is then swung over for the claw to engage the roller on the other side of the clamp opening. Then on the toggle lever being pressed down the three rollers of the clamp automatically locate on the pipe ends, which are brought into alignment and firmly supported ready for the welding operation. The holding pressure exerted by the rollers on the pipes can be adjusted through a knurled screw on the toggle strap.

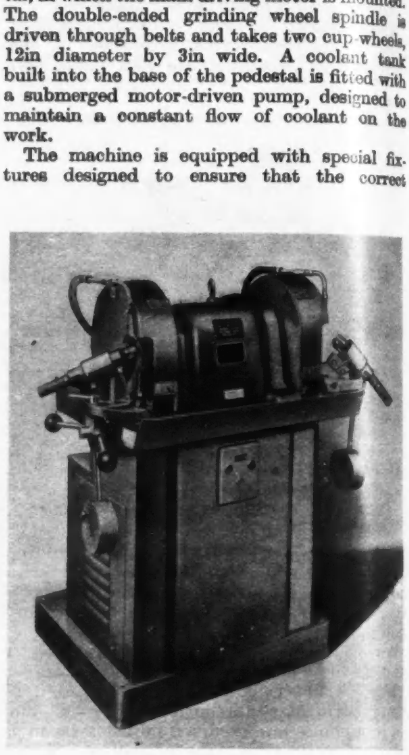
The clamp rollers are so positioned that the pipes can either be tack-welded or a fair length of run welded. Between the runs the clamp can be quickly and easily loosened and moved round the circumference of the pipes.

Grinding Machine for Tipped Bits

WE have received particulars of a special grinding machine for the tungsten carbide drilling bits used for coal and stone cutting, which has been designed by T. S. Harrison and Sons, Ltd., of Heckmondwike, in collaboration with Siemens-Schuckert (Great Britain), Ltd., of Brentford, Middlesex.

The new machine, illustrated in the engraving below, is built on a rigid fabricated steel pedestal, in which the main driving motor is mounted. The double-ended grinding wheel spindle is driven through belts and takes two cup wheels, 12in diameter by 3in wide. A coolant tank built into the base of the pedestal is fitted with a submerged motor-driven pump, designed to maintain a constant flow of coolant on the work.

The machine is equipped with special fixtures designed to ensure that the correct



GRINDING MACHINE FOR TIPPED BITS

cutting angles are ground on the bits throughout their working life. In these fixtures the bits are held in holders, which slide in long housings designed to prevent any vibration during the grinding operation.

The carbide tips are ground on the left-hand wheel of the machine and the steel body is backed off on the right-hand wheel. All four cutting edges of the tip are ground at one setting in the left-hand fixture, and during each operation one face of the bit is held firmly against an accurately machined surface by a knurled screw. To set the fixture for grinding the outer or the inner edges of the tips the housing, together with the holder, is swivelled and locked by a simple clamping screw. An adjustable stop can be set to ensure that whilst the inner edges of a bit are being ground the opposite tip is not touched by the wheel.

The holder on the right-hand side of the machine, which is used for backing off the steel body, is not made to swivel as provision is only necessary for grinding the outer edges of the tool.

A pendulum weight beneath each of the grinding fixtures ensures smooth and easy movement of the work on the wheel, and ball-ended hand levers provide an easy grip for the operator. With the fixtures in use no special setting work is required and, once a bit has been inserted and clamped in a holder, the subsequent grinding operation is simple, rapid and consistently accurate.

IRON AND STEEL SCRAP.—An Order increasing the scrap iron and steel merchants' trade allowance for maximum prices for scrap iron and steel from 3¾ per cent to 5 per cent has been made by the Minister of Supply. It came into force on February 12th.

The Testing of Motive Power Machinery*

By T. W. F. BROWN, D.Sc.

No. III—(*Continued from page 184, February 9th*)

Marine Work

In marine work a new feature, namely, shore testing of propulsion machinery, has been instituted. In the United States the Engineering Experiment Station at Annapolis tests gas turbine units, diesel propulsion units and similar machinery, and the Naval Boiler and Turbine Laboratory, Philadelphia, carries out full-scale tests on boilers, turbines, gears and auxiliaries, and in the particular case of gears many of the tests are carried out to destruction.

In this country the Admiralty Engineering Laboratory tests diesel machinery for naval use; a Naval Wing is being constructed at the National Gas Turbine Establishment to test gas turbine propulsion machinery developing powers up to 10,000 h.p.

In the case of heavy oil propulsion machinery the various manufacturers have facilities to test the engines on their erecting beds, but for high-powered turbine machinery facilities to carry out full-scale tests have only been available in Britain since 1947. The Pametrada Research Station commenced building in 1945. It was designed to meet the maximum requirements for both naval and merchant ships, and provision was made for dealing with powers up to 60,000 h.p. per shaft. For a considerable time the need had been felt for a testing station in this country at which full-scale tests could be carried out on such machinery. Consumption trials of marine machinery for both naval and merchant ships have, of course, been carried out at sea on many occasions, but their value has been limited by the difficulties inherent in sea trials, namely, the difficulties of making accurate measurements of power output, except for vessels with electrical transmission, of separating the auxiliary steam from that taken by the main turbines, and of making long runs under uniform conditions. In turbine machinery trials on shore there has rarely been sufficient boiler and condensing capacity to carry out load trials in the maker's works, and the usual steaming trial prior to installation has been a light-load overspeed test. To obtain the accurate performance data which is essential for the development of high-efficiency machinery, it is therefore necessary to test the sets at full load on shore where the fluctuations caused by marine conditions are eliminated and where all quantities can be accurately controlled and measured. A full description of the station has been given.§

The following description of full-scale machinery trials is issued by permission of the Admiralty, for whom and under whose supervision the trials were carried out. The complexity of the instrumentation involved in such a trial may be judged by the fact that during many of the runs no less than 525 separate quantities were measured. Apart from the measurement of temperatures by thermometers, 112 thermocouples were fitted to various points in the installation and continuous records made during transient operating

Table IV—*Diesel Engine Trials Results*

Year of test	1902	1911	1926	1949
Type	4-stroke, single-acting, single-cylinder	4-stroke, single-acting, single-cylinder (prototype for "Jutlandia")	2-stroke, opposed-piston, 4-cylinder	2-stroke, opposed-piston, 6-cylinder
Authority	Ade Clark	Barclay Curle	Marine Oil Engine Trials Committee	Doxford
Brake horsepower	39·2	124·4	2,910	6,560
Revolutions per minute	182·5	143·2	87·4	115·7
Mean indicated pressure, pounds per square inch gauge	117·6	96·2	101	86·8
Indicated horsepower	52·3	170·6	3,330	7,603
Mechanical efficiency	0·75	0·73	0·875	0·86
Air injection pressure, pounds per square inch gauge	850	910	—	—
Fuel injection pressure, pounds per square inch gauge	—	—	9,200	6,200
Exhaust temperature, deg. Fah.	—	779	632	740
Fuel consumption:				
Pounds per brake horsepower-hour	0·461	0·4435	0·416	0·348
Pounds per indicated horsepower-hour	0·346	0·3235	0·360	0·300
Gross calorific value of fuel, B.Th.U. per pound	19,296	19,500	18,220	19,620
Specific gravity of fuel	0·922	0·860	0·949	0·864
Indicated thermal efficiency,* per cent	38·1	40·3	38·8	43·2
Brake thermal efficiency,* per cent	28·6	29·4	33·5	37·2
Heat to coolant, per cent	28·2	32·4	19·7	19·4
Heat to exhaust (by difference), per cent	43·2	38·2	46·8	43·4

* Based on gross calorific value of fuel.

* James Watt Lecture, Greenock Philosophical Society. Abstract.

§ "Trans.," N.E. Coast Inst., Vol. 64, 1947.

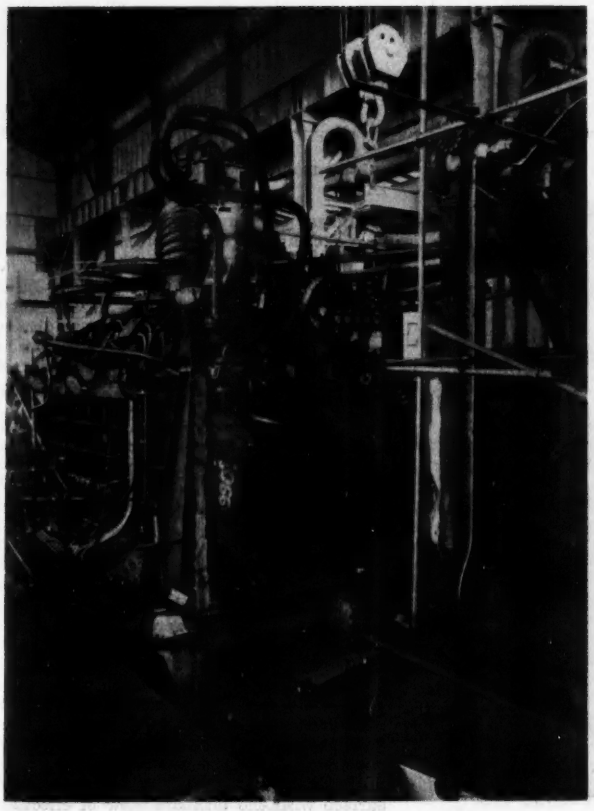


Fig. 2—Erecting Steam Turbine for Testing

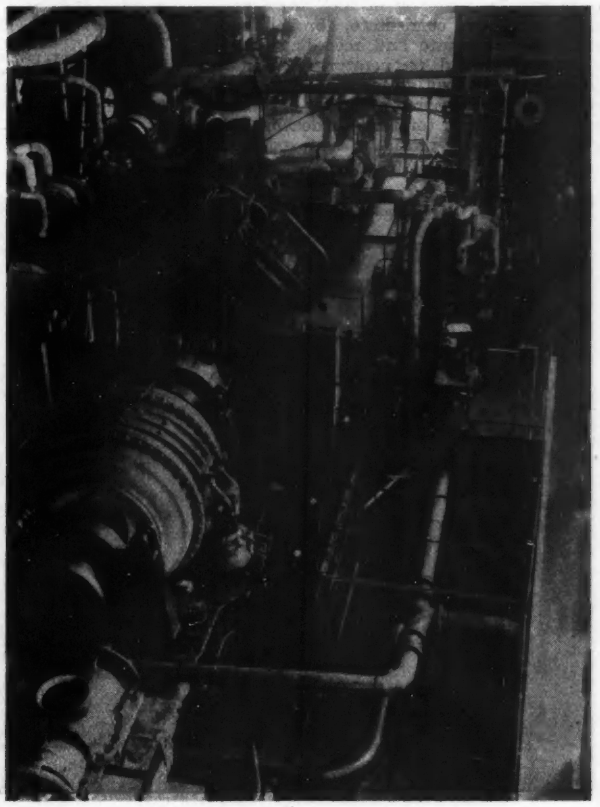


Fig. 3—Testing of Steam Turbine

FIG. 4—TESTING OF GEARING TO DESTRUCTION

conditions by means of automatic multi-point recording instruments. Many other readings were also taken using thermocouples and potentiometers and direct indicating instruments to carry out the required tests involving 407 hours of running, of which twenty-three hours aggregated from various trials were devoted to running under astern conditions. Figs. 2 and 3 give general views of the machinery preparing for and under test. The tests fall into two main categories :

(*a*) Calibrating trials mainly concerned with efficiency and performance of the machinery.

(*b*) Associated researches which were carried out simultaneously with the other trials.

(*a*) TRIALS OF PERFORMANCE OF MACHINERY

These trials included the accurate measurement mostly by weighing of fuel, main condensate, auxiliary condensate, brake load, revolutions per minute and recording of all steam pressures and temperatures at entry to and in the various stages of the turbine. Gland steam was measured by means of orifices at each point and in total by condensing and weighing the condensate. Air removed from the condenser by the air ejectors was passed through a calibrated gas meter to atmosphere.

After preliminary trials to clean the lubricating oil system and overspeed trials which show up any tendency in the bearings to overheat, the main consumption trials were commenced. These trials cover the power range from 5 per cent power to overload at different vacua, steam conditions and revolutions both above and below those corresponding to the propeller law. During such runs readings of noise level, including the recording of the components of noise and torsional and axial vibration records, were taken.

Manœuvring trials followed in which the distortions and temperatures in every part of the machinery, including temperatures in the rotor bores at selected axial positions, were measured, in conditions of starting with the machinery cold and bringing up to full power rapidly. The instruments fitted enabled the speed at which this could be effected without damage to the machinery to be determined.

Acceleration trials, and crash stop trials were also carried out. Astern trials for consumption and to measure the rise in temperature in the ahead blading were also carried out at various inlet steam conditions and vacua. The astern trials were specially severe as after hours of such running the machinery was set to run ahead as rapidly as the nozzle control valves could be operated.

It will be clear that after such trials are successfully completed, confidence can be felt in the machinery when it is installed in the ship.

TABLE V—*Gas Turbines*

Year of test	1945	1947	1947	1950
Unit	2,000kW experimental unit	2,500 h.p. engine for M.G.B.	10,000kW peak-load unit for power station	3,500 h.p. experimental unit
Cycle	Closed cycle, with intercooling and heat exchange, no reheat	Open cycle; no heat exchange, intercooling or reheat	Open cycle, with intercooling and reheat; no heat exchange	Open cycle, with heat exchange; no intercooling or reheat
Authority	Quiby	Metro-Vick	Meyer	Skortz and Gessner
Net output	2,044kW	2,550 h.p.	12,020kW	3,000 h.p.
Turbine inlet temperature, deg. Fah.	1,269	—	H.p. turbine, 1,051, L.p. turbine, 1,063	1,520
Air inlet temperature, deg. Fah.	61·4	—	56	80
Pressure ratio of compressor	3·77	—	11·26	4
Fuel rate, based on power at turbine coupling, pounds per shaft horsepower-hour	0·425	1·06	—	—
Gross calorific value, B.Th.U. per pound	18,288	—	—	—
Thermal efficiency, per cent	32·6	—	—	17·6
Fuel rate based on net output, pounds per kilowatt-hour	0·59	—	0·816	—
Thermal efficiency, per cent	31·6	—	23·3	—

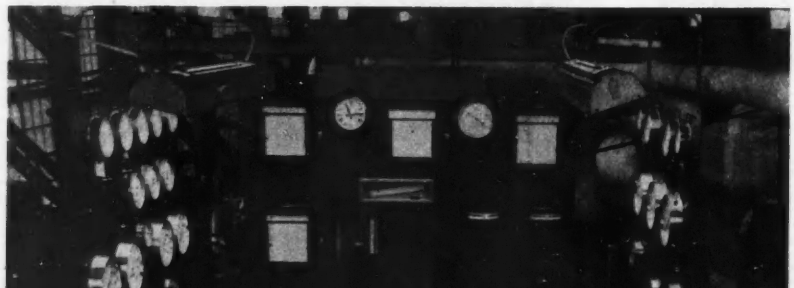


FIG. 5—INSTRUMENT PLATFORM FOR STEAM TURBINE TESTS

(*b*) SOME OF THE ASSOCIATED RESEARCHES CARRIED OUT SIMULTANEOUSLY WITH THE PREVIOUS TRIALS

(a) *Strain Gauges on Quill Shafts.*—In order to assess the distribution of torque between each pair of quill shafts and also to give some idea of power distribution between the turbines, strain gauges were affixed to the quill shafts and connected through slip-rings to a specially developed indicating instrument.

(b) *Turbine Rotor and Gear Movement by Capacitance Gauges.*—Electronic capacitance gauges were fitted to various points on the gearing and turbine shafts to indicate vibrations and movements of the gear wheels and turbine rotors.

(c) *Pressure Drop Measurements in Steam Piping.*—Measurements were made of pressure drops along the main steam piping, across boiler stop valve, and main steam strainer. These measurements were made by mercury column in a steel tube, the mercury level being determined by means of γ-rays and a suitable pick-up instrument.

(d) *Condenser Development : Heat Transfer Measurements.*—A series of pitot tubes and thermocouples was inserted in the tubes of the main condenser to ascertain the distribution of heat transfer over the condenser heating surface with the ultimate view of effecting an improved design of condenser.

(e) *H.P. and L.P. Casing Temperatures.*—Thermocouples were fitted at strategic points in both h.p. cylinder and l.p. inner and outer casings.

(f) *Relative Expansion of H.P. Rotor.*—Three methods of ascertaining the axial position of the aft end of the h.p. rotor relative to the casing whilst running were tried.

(g) *Turbine Distortion.*—Brackets were fitted at many points on the h.p. and l.p. turbine with reference points on the gear case and on the test bed for the use of Taylor, Taylor, Hobson alignment telescopes.

(h) *Rotor Bore Temperatures.*—Rotating thermocouple assemblies were inserted in the bores of both h.p. and l.p. turbines, the leads being led to slip-rings at the forward ends of the rotors.

All instruments, including the hydraulic brake, were calibrated before and after every series of tests, usually by reference to a standard—for example, deadweight for pressure gauges and melting points of pure materials for thermocouples.

Fig. 5 shows the instrument platform for the steam turbine tests. This platform is arranged about 10ft above the machinery level, so that all gauge pipes are self-draining. The platform also enables the number of observers to be kept to a minimum during trials and keeps the test instruments and observers clear of the gauges used at the control position. This is naturally important when rapid manœuvring trials are in progress. Some of the recording thermographs, the Kenotometers and temperature indicating points can be seen in the photograph.

The accuracy of such trials has been shown to be $\pm\frac{1}{4}$ per cent, and the results are reproducible within this figure on repeat trials.

Before completing this rapid survey a new type of test on gearing should be referred to. This is the testing by means of back-to-back tests at increasing torques until destruction of the gearing is effected. Fig. 4 shows a set of gears set up for test, one box being torqued against the other by means of a hydraulic torque loader. The gears are rotated by means of a steam turbine, which supplies the power corresponding to the gear losses. At each level of load an examination of the gear is carried out to determine wear, pitting and possible cracking of the teeth, and the load is then increased and the gears run again until tooth breakage occurs. In this way the real factor of safety and the mechanism of failure is determined for each combination of material or gear-generating process employed.

Conclusion

It is hoped that this review, limited to an examination of machinery and testing at fifty-year intervals from 1800 to 1950, will show the great advance which has been made by the accumulated work of scientists and engineers over this period. When Watt produced his fundamental improvement in the steam engine of a separate condenser, he was able to make a four-fold improvement on contemporary machinery. No such spectacular change is now possible as within the period reviewed machinery has been perfected from thermal efficiencies of less than unity to a maximum of about 40 per cent. In this present day, with established motive power machinery, we are working in the region of diminishing gains. It is only when we consider the potentialities of the cooled gas turbine operating at high temperatures, which may be developed as a result of such testing as described, that further improvements in the region from 40 to 50 per cent thermal efficiency may be possible. It is hoped that this paper on full-scale testing will again enable us to assess the magnitude of the work carried out by Watt during his lifetime as the father of full-scale testing of motive power machinery.

The various tables reproduced with this abstract were amongst those included in the paper.

Loading Devices for Gear Finishing Machines

TO avoid the manual handling of individual gears in high-speed production, an interesting line of automatic loading devices for gear finishing machines, to suit different gear types, sizes and production requirements, has been developed by the Michigan Tool Company, Detroit, 12, Michigan. The devices are for use on both rack and rotary gear finishing machines, and, if it is desired to operate the machines conventionally, the devices can easily be removed. Elimination of manual handling has been carried to the point of making unnecessary even the use of mandrels for mounting of gears and pinions between centres, special pneumatic headstock centres being available in which the mandrel forms part of the centre. Furthermore, stripping from the mandrel is automatic.

In general, the devices fall into three major classes :—

(1) The gravity chute feed and unload mechanism, for smaller gears.

(2) The chute feed and indexing mechanism with positive loading.

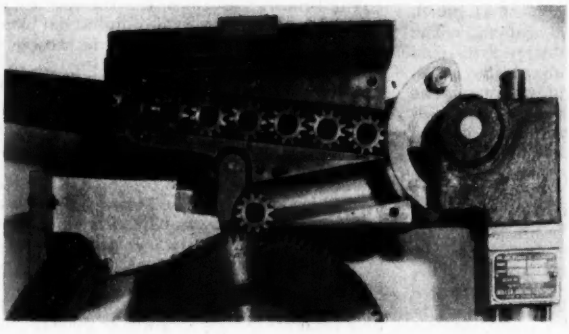
(3) The jaw type conveyor loaders for individual and cluster gears.

All of these loading devices are so designed as to provide electrical and mechanical interlocks to interrupt the machine cycle should any part of the mechanism fail to operate properly.

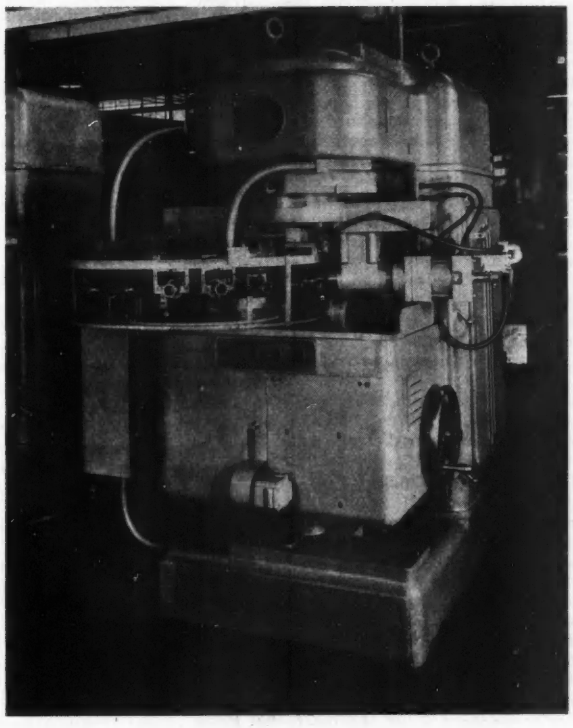
In the gravity feed loader shown herewith, pinions to be shaved are loaded into a chute, either manually or mechanically. As the gears gravitate down this chute the foremost one rolls into a shuttle rotor. The opening in this shuttle is so timed that when a gear is lowered to the cutter feed chute the end of the upper chute is sealed by the rotor and only one gear at a time can enter the lower chute. When the rotor is in the "down" position a lever, actuated mechanically, positions a finger above the shaving cutter so that the gear can roll into mesh with the cutter, but no further. With the gear in this position the pneumatic headstock centre comes into action and one centre, which enters the hub of the gear with a light press fit, serves as a mandrel. The stationary tailstock centre locates the gear axially. The machine then goes through its cutting cycle, while the finger moves back out of the way and the shuttle returns to receive another gear. At the end of the cycle the headstock centre retracts, stripping the gear from its mandrel. The rotary cutter then turns slightly and rolls the gear off into the exit chute. The next gear enters the lower chute and the sequence is repeated.

The device is claimed, not only to reduce the amount of labour and attention required, but also to be effective in increasing the maximum output of the machine. A rotary gear finishing machine with a device of this kind and producing a pinion as shown is capable of turning out 300 gears per hour. To prevent improper axial positioning of the gear the headstock centre locates the pinion. The tailstock is provided with a "power" linkage to ensure travel of the headstock centre up to a fixed position. The gravity feed shown overleaf is similar to that described above, except that the gear drops directly into position and a plunger entering above it prevents a second gear from following. A wedge-shaped locator is used in addition to the locating finger to ensure accurate positioning before the centres enter the pinion hub.

Another indexing device used is particularly suitable for pinions shaved on rack machines and is exceedingly fast in operation. The loading chute is located at one side of a vertical indexing plate. Gears are indexed to the shaving station by a series of index movements and finished gears are unloaded from the index plate by the unfinished gears. This action is effected by the same stroke of the headstock



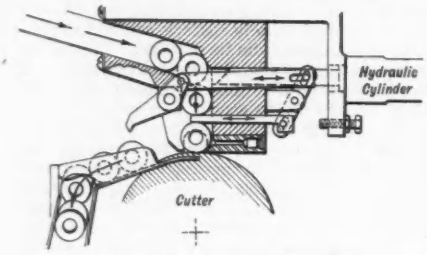
GRAVITY CHUTE AND SHUTTLE FEED LOADER



CONVEYOR PASSING THROUGH GEAR FINISHING MACHINES

cylinder which pushes the mandrel centre into the gear. An inner circle of bores in the index plate is used for indexing by means of a locating plunger, in order to provide an additional safeguard. If the locating plunger cannot enter a bore for any reason the cycle of the machine is automatically interrupted. The idle time on a machine, when using this device, is virtually only the time required to index the plate 30 deg. (depending upon the number of gear-carrying positions) and for the headstock centre to operate. This time is so short—less than two seconds—that the cutter does not come completely to rest before the next gear is ready for shaving, unless the motor is intentionally stopped.

An entirely different method of automatic machine loading is illustrated on page 235. The



PLUNGER GRAVITY CHUTE FEED

underpass gear finishing machine shown is designed so that a conveyor can pass through the machine, instead of passing along it in the conventional manner. Furthermore, gears are finished automatically while on the conveyor, without any manual or mechanical machine loading being necessary. To hang a gear on the conveyor, light finger pressure on their top opens the work jaws and the gear is inserted. The release of pressure closes the jaws and, once loaded, the conveyor carries the gear into position above the finishing cutter. When air-operated centres on the machine engage the gear, a mechanical finger separates the jaws and leaves the gear free to move at an inclined axis on the cutter. The machine goes through its cutting cycle and the mechanical finger releases to re-engage the gear in the conveyor jaws. The centres retract and as the conveyor moves the gear out of the cutting position the next gear moves into position. Indexing, engagement by the centres and release of jaws takes a total time of 2¼ seconds. As an example, gears of 14 pitch, 2⅝in diameter, and ⅞in face width require only 17½ seconds to finish, or a total floor-to-floor time of 20 seconds.

All movements of the machine and conveyor are electrically interlocked and automatically sequenced. Should a conveyor not index to the correct position, the centres not engage the gear properly, or the jaws not release, the cycle is interrupted. As the conveyor itself controls machine operation, the usual electrical controls on the front of the machine are eliminated. The same conveyor can be arranged to pass through a battery of rotary gear finishing machines, facilitating the automatic finishing of all the individual gears on a cluster unit.

American Engineering News

(From our American Correspondent)

Natural Gas Supply for New York City

The 1840-mile long main pipe-line, extending from the Texas-Louisiana oil fields to New York City, has now been completed and natural gas is being supplied to domestic and industrial users in the city. Since the cost of natural gas is substantially lower than that of manufactured gas, a fall in the local gas rates is expected in due course. At present a mixture of natural and manufactured gas is being distributed by companies in the metropolitan area, and the entire pipe-line is carrying 250,000,000 cubic feet of gas per day but gradually the flow will be increased to the full capacity of 555,000,000 cubic feet per day. The Greater New York area has been allocated approximately one half of the total flow; various public utility companies in New Jersey and in Philadelphia will take another 152,000,000 cubic feet, and a small amount will go to companies in Louisiana, Mississippi, Alabama, Georgia, North and South Carolina, Virginia and Pennsylvania. The remaining 100,000,000 cubic feet of daily capacity have been reserved for New England, but cannot be delivered until the completion of the pipe-line being constructed by the North-Eastern Gas Transmission Company.

Development of a Zirconium Oxide Refractory

The Norton Company, of Worcester, Massachusetts, has announced that it is making available commercially a new refractory product known as fused, stabilised Zirconia, which is able to withstand working temperatures of up to 4600 deg. Fah. Fused zirconia was first produced in the laboratories of the company in 1946 but considerable development work was required before laboratory costs could be reduced to commercially feasible levels. In granular form the substance is sold at a price of 50 cents per pound. A United States patent for the zirconia manufacturing process and its products was granted to the company recently. With regard to potential uses for the substance, it is said to possess an extremely low heat conductivity coupled with good resistance to thermal shock, and it is said to resist attack by other molten metals and to retain its form when manufactured into moulded shapes without signs of failure or distortion in high temperature production processes.

Gas Turbine-Powered Aircraft

The initial flight of the first American gas turbine-powered commercial aircraft took place recently at San Diego, California. The aeroplane is a conventional "Convair" transport, built by the Consolidated Vultee Aircraft Corporation, which has been adapted for turbo-propeller engines. It is powered by two Allison Model "501" engines, made by the General Motors Corporation, each of which develops 2750 h.p. and weighs only 1250 lb. The "T-38" military version of these engines is already being used in the XP5Y flying-boat and the XA2D carrier-based attack aircraft of the U.S. Navy. The "Convair" commercial transport has a gross weight of 41,790 lb and a fuel capacity of 1200 gallons. The standard model is designed to carry forty passengers, but this initial turbo-propeller adaptation has seats for only eight persons. The remainder of the fuselage is being reserved for cargo space. During the testing of the aircraft this space is being used to accommodate the instruments and other equipment required for flight research. Results of the tests will be made available to aircraft manufacturers, airlines and the military services and, eventually, the aircraft itself may be turned over to the U.S. Military Air Transport Service and the commercial airlines for extended service testing.

A Large Ore-Carrying Vessel

The National Steel Corporation recently announced plans for the construction of a new ore-carrying vessel, which it is claimed will become the largest ship in the history of inland water transport a title at present still belonging to the ore carrier "Wilfred Sykes," of the Inland Steel Company, launched in 1950. The new vessel will have an overall length of 690ft, a beam of 70ft, a moulded depth of 37ft and an ore capacity of 19,500 gross tons at a draught of 24ft, which is the maximum available in existing channels. However, the ship will be designed for a greater draught so as to take advantage of any future increase in the depth of water. This will increase the carrying capacity of iron ore cargo to 21,000 tons. The ship's keel will be laid next August at the yard of the American Shipbuilding Company at Lorain, Ohio, and she is due to be launched in the summer of 1952.

French Engineering News

(From our French Correspondent)

The French Government has decided to control certain raw materials, including copper, tin, zinc, lead and their alloys. Both the electrical and mechanical industries are expected to be seriously affected by the re-imposition of controls.

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A train ferry, the "Saint-Germain," which will serve the Dover–Dunkerque line, is now nearing completion. It is being built by the Elsinore Shipbuilding and Engineering Company in Denmark for the French Railways. The overall length of the vessel will be 115·72m and its breadth 18·95m; the maximum draught is given as 4·12m. It will be a twin-screw vessel and will have a speed of 18 knots, and will carry 500 passengers. The vessel is generally of welded construction, although some riveting has been used, and it will carry four sets of railway tracks, the two centre lines intended for wagons-lits.

The engine-room is situated directly below the car deck, about amidships, and aft of it there is a compartment containing third-class *couchettes*. First-class sleeping saloons are forward of the engine-room.

The "Saint-Germain" will also be able to carry twenty-five automobiles.

Anti-fire precautions include a series of fire-proof screens which can be dropped if necessary to cut off any section of the vessel, which will be equipped with fire detectors.

The "Saint-Germain" will be driven by two diesel engines. They are two-stroke, nine-cylinder engines of the standard design of Burmeister and Wain, with a maximum speed of 195 r.p.m. and a mean of 180 r.p.m. Electricity is supplied by three generator groups of 200kW driven by four-stroke diesel engines and generating 220V d.c. There will also be a reserve 25kW engine and a group of 220V accumulators.

The vessel has a forward rudder to facilitate handling in port, which has electro-hydraulic control. There are also two rudders aft controlled by the same method, and the deck machinery is electrically driven. The wagons-lits accumulators can be charged by the ship during the crossing and heated by steam apparatus. The "Saint-Germain" is expected to enter service next July.

* * *

The French Minister of the Interior is studying a plan for the removal of industrial plant to isolated sections of the country in the event of war. Some £20 million, it is estimated, will be necessary to carry out the transfer. This year £1 million has been set aside for this purpose, in case of need.

* * *

The work of changing the course of the River Moselle is now in progress. The object of this project is to facilitate the passage of German coke to Lorraine, and it forms part of the Schuman Plan. One of the first steps in the project was the construction of hydro-electric plant on the river at Coblence. This plant, which is now in operation, comprises four generators with a power of 4000kW. The barrage built for the plant has made the Moselle navigable between Coblence and Treves.

* * *

More oil has been found in Morocco. Recent borings produced oil at six different points in the Sidi-Féli area. It is estimated that this new field has a reserve of about 1 million tons. This is no more than an estimate, however. The field may, indeed, be more important.

* * *

Work on the l'Oued-el-Abid dam in Morocco has started. The Abid River is being dammed at a point which will enable its waters to be used by a new power station and then carried by conduits to Afourer where it will drive the turbines of a second plant, larger and more important than the first. The water will afterwards be used to irrigate 100,000 hectares of land.

Work on this project is expected to last two or even three years, and the two hydro-electric plants are expected to produce 460 million kWh between them.

Industrial and Labour Notes

Railway Wages

The report was published on Wednesday of the Court of Inquiry, set up recently by the Minister of Labour, to examine wage claims advanced by the three railway unions. The claims were for an increase of 10 per cent for members of the National Union of Railwaymen, 15 per cent for members of the Associated Society of Locomotive Engineers and Firemen, and 7½ per cent for members of the Railway Clerks' Association.

The recommendations made by the Court propose increases of about 5 per cent in the wages of the majority of grades, such increases to be conditional on the acceptance by the unions of changes in working arrangements which would economise manpower and increase the efficiency of railway working. These recommendations are, therefore, almost identical with the offer made towards the end of last year by the Railway Executive, an offer which was rejected by the unions on the ground that wage increases should not be conditional upon the acceptance of the proposed changes in working arrangements. The principal difference in the Court's recommendations is a bigger increase for the higher grades of railwaymen than was offered by the Railway Executive. The Court proposes that the rate for the highest grade engine drivers and motormen should be increased by 10s. 6d. a week instead of 7s. as offered by the Executive, that the rates for special classes of signalmen should be increased by 9s. 6d. instead of 7s., and that the highest categories of salaried staff should receive increases of £30 to £35 a year instead of £25.

The Court suggests that, subject to the acceptance of the changes in working conditions, the increases should be retrospective to January 1st. In setting out its conclusions and recommendations, the Court says that it was "impressed by the extent to which industrial relations have been and are being impaired by inter-union rivalries." It urges that differences between the unions over the question of organisation should not be allowed to prejudice the proper working of collective bargaining on British Railways.

The T.U.C. and Rearmament

Sir Vincent Tewson, general secretary of the Trades Union Congress, writing in the T.U.C. monthly journal, observes that to spend nearly £5,000,000,000 on the three-year defence programme and to keep up vital exports inevitably demands extra hardships. He asserts that "the Government will do its human best to spread the burden fairly" and says that a helpful response from the trade union movement is certain.

Already, Sir Vincent continues, the T.U.C. General Council has called on affiliated unions to assist in all practicable measures to meet the crisis in fuel supplies. It has asked that miners now in the Forces should be given the chance to return to their pits if they wish. The slowing-down or cancelling of the call-up of young miners to national service, it is added, might further help to arrest the outflow of manpower from the industry at a time when its services were never more urgently needed. Even so, Sir Vincent emphasises, every scrap of ingenuity will be required to ensure that our most precious raw material is used as sparingly and efficiently as possible. Sir Vincent goes on to remark that as with fuel, so with raw materials. Their high cost and their shortage in the world's markets mean that there must be less scrap and spoilt work in our factories. The more efficiently raw materials are used the lower will be the cost of goods and the production of munitions and the lighter the burden of taxes.

The ingenuity with which these difficulties are surmounted, Sir Vincent urges, must be applied to the industrial problems which will be presented by the temporary recall of some of the reservists to the armed Forces. It will be hard work, the article declares, to make good the losses, and rigidity of approach to the problems will not be helpful. But, it is stressed, the thought given to ways of saving and to the temporary substitution of materials and methods will bring long-term benefits in efficiency. Much will depend, Sir Vincent says, on how the skill of the workers is used. With no reserves of unemployed men and machines, the 500,000 people needed in engineering, vehicle building, aircraft construction and in the ordnance factories, must come from the less vital centres of industry. Training schemes must raise the numbers of skilled workers. Hours of work must be adjusted to attract women recruits for full-time and part-time work and the services of elderly workers, able and willing to continue at their jobs, must not be lost through arbitrary schemes of retirement.

The F.B.I. and the Price of Coal

The Federation of British Industries has expressed, in a letter sent by Sir Norman Kipping, its director-general, to the Minister of Fuel and Power, the concern which it feels at the further rise in the price of coal. The letter says that other industries have proved that by increased productivity costs can be kept down below the levels that would otherwise have been necessitated by rises in the cost of imported materials.

Undertakings have now been given for an increase in coal output and the F.B.I. feels, therefore, that it is precipitate to raise the price before those undertakings have been given time to take effect, and to assume that the coal industry cannot do the same as other industries. The added burden represented by the rise in price, the letter continues, is equivalent to more than £50,000,000 a year, and as all British industry is founded on coal, that rise in price will add to costs everywhere. Increase in coal output per man would materially reduce, if not cancel, the need to raise from consumers such an enormous sum.

In any case, the F.B.I. claims, in reverting to a flat rate increase, the National Coal Board has departed from its undertaking to relate the price to grade of coal. Firms which have bought plant to burn cheaper grades are thus most unfairly victimised. The letter asks, therefore, that immediate steps should be taken to reconsider the latest price increase and the manner in which it has been imposed.

Engineering Wages

The ban on piecework and overtime as a protest against the piece-rate clause in the engineering and shipbuilding wages agreement was still being imposed in the early part of this week by workers at some establishments in the north. The Minister of Labour, Mr. Bevan, was questioned in Parliament last week about the matter and was asked what steps he proposed to take to remedy it.

In his reply, the Minister pointed out that the National Arbitration Tribunal refrained from making an award and that the resultant settlement was embodied in a National Wages Agreement to which both sides of the industries were parties. In general, he said, the agreement had been well received but in a few areas some dissatisfaction had been expressed that pieceworkers already earning above the new minimum would not benefit. That dissatisfaction had been shown by a reversion to day work and an embargo on overtime by pieceworkers in a number of engineering establishments.

The Minister went on to say that the position was considered (on Monday of last week) at a joint conference of the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions, when it was agreed that there should be a resumption of piecework and overtime working so that any question of low piecework earnings might be reviewed under the procedure agreement in the industry. He stressed the importance and urgency of securing return to normal working and of dealing with any question arising in a constitutional manner. But he maintained that it would not be proper for his department to intervene.

Education Scheme for Port Workers

At the end of last week there was issued a report of a conference, which in recent months has been discussing a scheme to give port workers a greater interest and understanding of their work. The Institute of Transport has been assisting the work of the conference, at which a number of interested organisations were represented, including the Docks and Inland Waterways Executive, the National Dock Labour Board, the National Joint Council for the Port Transport Industry, the Association of Technical Institutions and the Dock and Harbour Authorities' Association.

The report of the conference suggests that there is a need for elementary courses of study directly connected with port work, which would meet the educational requirements of employees who do not take advantage of existing facilities. The subjects of the course proposed in the report are port traffic, port working, and port organisation and finance, and care has been taken, it is stated, to ensure that in particular areas, where appropriate, adjustment in the syllabuses is made to suit local conditions. The Institute of Transport has agreed to co-operate in the operation of the scheme and will be responsible for the approval of the syllabuses and the maintenance of examination standards. Certificates awarded to successful candidates will be issued by the Institute. The hope is expressed in the report that port employers and the trades unions will give encouragement to port workers to pursue the courses of study that are being arranged. Further details of them can be obtained from the Institute of Transport, 80, Portland Place, London, W.1.

Iron Ore Supplies

The European Iron Ore Working Group, set up by the United Nations Economic Commission, met recently in Geneva, and from information presented to it, reached the conclusion that although 3,400,000 tons more ore would be available in 1953 than previous figures had shown, there would still be a deficit. According to present plans, the group states, Europe expects to produce 15 per cent more pig iron in 1953 than it did in 1950, but while many ore-producing countries are planning for greater outputs, the development of ore production is a matter of years and not months. That is why the governments of the countries participating in the work of the Economic Commission for Europe are concentrating on ore production in the year 1953 and subsequently.

By gauging the demand prospects at that date, they hope to give indications to producers which would help them in their planning. The iron ore working group also took into account, of course, the fact that countries planning further expansion of steel plants need to be sure of the availability of raw materials, including knowledge of prospective sources and qualities. In its effort to ensure adequate supplies of iron ore, the group is undertaking a study of prospective European supplies of the major categories of ores. On account of the relationship of ore requirements to supplies of coke and scrap, it is hoped before the group's next meeting in March to obtain information on prospective metallurgical coke supplies for 1953. Participating countries are also being asked to provide information on the rate of scrap consumption anticipated for 1953.

Notes and Memoranda

Rail and Road

LOCOMOTIVES FOR EAST AFRICAN RAILWAYS.—Sixteen locomotives have been ordered by the Crown Agents for the Colonies for the Kenya section of the East African Railways. This order is part of the projected expenditure of £20,500,000 on post-war development. The engines, which will be of the "56" class Beyer-Garratt type, with an overall length of 89ft, are to be built by Beyer Peacock and Co., Ltd., of Gorton, Manchester. Production is to be completed in 1953 and the locomotives are expected to be in service by 1954.

COAL ECONOMY ON THE RAILWAYS.—The Railway Executive has announced that reductions in passenger train services on British Railways, which have been made in the last two or three weeks, have effected a reduction in coal consumption of 5750 tons a week. In order to meet the Government's requirements for saving coal, however, further reduction of passenger train services were made from February 12th. The coal consumption of British Railways has now been reduced by 10,000 tons a week. The Railway Executive emphasises that there is to be no curtailment of essential freight services, which accounts for the relatively serious effect of the fuel-saving measures upon ordinary passenger train services.

Miscellanea

HAWKSLEY GOLD MEDAL AWARD.—Dr. A. T. Bowden and Mr. J. L. Jefferson, of C. A. Parsons and Co., Ltd., have been awarded the Thomas Hawksley Gold Medal by the Institution of Mechanical Engineers for their paper, entitled "The Design and Operation of the Parsons Experimental Gas Turbine," which was considered the best paper submitted during the 1950 session.

DISHED ENDS AND STAYED SURFACES.—The Association of Engineering and Shipbuilding Draughtsmen has now issued the third edition of an illustrated paper by C. C. Pounder on "Dished Ends and Surfaces." The paper was first published in 1923, and the text has now been considerably revised. Copies of the paper, price 1s. to members and 2s. to non-members, can be obtained from the Association, 96, St. George's Square, London, S.W.1.

AN IRON AND STEEL EXHIBITION.—The British Iron and Steel Federation has organised an educational exhibition which will be staged in steel-making areas throughout Britain during the coming year. This exhibition is intended mainly to give young people a broad picture of the iron and steel industry, the men who work in it, its processes and products, and the industries it serves. It has been specially designed to tell the story of iron and steel and to interest potential entrants to the industry. The exhibitions are to be held at Swansea, Warrington, Sheffield, Bilston, Glasgow, Darlington, Barrow, Scunthorpe and Cardiff.

INTERNATIONAL RUBBER CONFERENCE.—An international rubber conference opened in London on February 5th with delegations present from Canada, Ceylon, France, Indonesia, Italy, the Netherlands, Thailand, the United Kingdom, the British Colonial and Dependent Territories, the United States and Vietnam. The purpose of the conference is to review the present and prospective supply-demand position of natural and synthetic rubber and to consider, in the light of the conclusions reached, whether any agreed recommendations for international action should be submitted to Governments, due regard being had to the interests both of producers and consumers.

THE INDEPENDENT PNEUMATIC TOOL COMPANY.—The Independent Pneumatic Tool Company, of Aurora, Chicago, Ill., U.S.A., has acquired control of Armstrong Whitworth (Pneumatic Tools), Ltd., Gateshead-on-Tyne. Each of these two firms manufactures a wide range of pneumatic tools for the motor-car, aircraft, shipbuilding, mining and general engineering industries. The acquisition of the British company will, it is stated, involve no change in policy, but there will be an interchange of information with a view to increasing production and the number of different units manufactured. Under the new arrangement Mr. W. Scott, who has for many years been managing director of Armstrong Whitworth (Pneumatic Tools), Ltd., has become chairman of the company, and Mr. R. G. Faverty, of the Independent Pneumatic Tool Company, has been appointed its managing director. At present Mr. E. R. Wyler, the American company's vice-president in charge of exports, is in this country in an advisory capacity, and he has with him engineers from the Chicago and Los Angeles factories of the Independent Pneumatic Tool Company.

LONDON MASTER BUILDERS' ASSOCIATION.—The President of the London Master Builders' Association, Mr. Dudley F. Cox, held a luncheon at the Waldorf Hotel last week, at which he discussed some of the problems which were likely to arise during his year of office. A great effort would be made to foster apprenticeship and the education of operatives and the training of foremen were topics which were being actively pursued by the Council of the Association. The President noted that conditions of sub-contracting were not always satisfactory and could be improved. He was in favour of incentive schemes and had made an arrangement whereby the Regional Technical Officer of the Ministry of Works would be available at certain times to advise the L.M.B.A., to encourage those in the building industry to obtain a better knowledge of the progress of research.

PROFIT SHARING IN INDUSTRY.—At a meeting of the Industrial Co-Partnership Association on January 31st, an interesting address was given by Mr. F. C. Braby, chairman of Frederick Braby and Co., Ltd., on the history and development of that firm's profit-sharing scheme. The scheme was actually started as long ago as 1863, in the form of a savings bank, through which leading workmen received regular sums through Mr. Frederick Braby, the founder of the company. A benevolent fund was also instituted in the same year. To-day, Mr. Braby said, many of the company's workpeople were shareholders, and, in addition, they had £47,000 in the firm's savings bank, secured by debentures issued to trustees and bearing a fixed rate of interest. Another point of interest mentioned in the course of the address was that, during the first World War, the firm was one of the first to institute joint consultation. The works committee then established was given the title of "Council for the Honour of Industry."

IMPROVED MOBILE CRANE.—A recent addition to the range of hydraulic crane vehicles made by F. Taylor and Sons (Manchester), Ltd., of Salford, 6, is similar to the firm's "Jumbo" Mark I and Mark II cranes, but it is fitted with an additional hydraulic jack, through which is obtained individual controlled movement of the outer jib independently of movement of the main jib. In this new model the independent control of the front jib permits working under a ceiling height of 10ft 2in as a crane or, when fitted with auxiliary equipment, 10ft 7in. With this new feature the crane hook or other lifting equipment can be controlled fore and aft without movement of the vehicle. With a little care on the part of the operator vertical movements of such things as platforms, stacking forks or crane hooks can also be made. In confined spaces loads can now be carried close to the machine with improved stability and they occupy less overall length to give greater ease of movement. The crane has a close turning circle of 14ft 6in radius.

Contracts

THE PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY has ordered two ships similar to the "Himalaya." One vessel has been ordered from John Brown and Co., Ltd., and the other from Harland and Wolff, Ltd. Following upon the success of the Denny-Brown stabilisers in the "Chusan," it is stated that the new ships will probably be so equipped.

GLASGOW CORPORATION WATER DEPARTMENT has recently announced the award of a contract to the value of £119,462 to Whatlings, Ltd., of Edinburgh and Glasgow, for the laying of 4¾ miles of 36in diameter concrete-lined cast iron water mains. The work includes two bridges over railway lines and the construction of reinforced concrete subway and shafts to carry the main under the Forth and Clyde Canal.

SIGMUND PUMPS, Ltd., has received a contract from the Shell Company for a group of process pumps for the second distillation unit at the Shell Refinery, at Cardon, Venezuela. In 1947, Sigmund Pumps, Ltd., supplied similar equipment for this plant so, with the new unit, pumps made by the firm totalling 20,000 h.p. will be used. This is stated to be the largest installation of its type yet equipped with British-designed process pumps.

THE BRITISH TANKER COMPANY, Ltd., has placed orders for twenty-one new oil tankers, totalling 426,000 tons deadweight, at an approximate cost of £21,000,000. Of the new ships six will be of 32,000 tons deadweight, twelve of 16,000 tons, and three of 14,000 tons. The orders for the large tankers have been given to the following firms:—John Brown and Co., Ltd., two; Harland and Wolff, Ltd., one; Vickers-Armstrongs, Ltd., one; and Swan, Hunter and Wigham Richardson, Ltd., one.

Personal and Business

THE IRON AND STEEL CORPORATION OF GREAT BRITAIN has now moved into offices at 4, Chester Street, London, S.W.1 (telephone, Sloane 0818).

MR. E. J. HOLDIN, director of Associated British Oil Engines (Export), Ltd., has been appointed, in addition, general sales manager of J. and H. McLaren, Ltd., Hunslet, Leeds.

ALFRED HERBERT, Ltd., Coventry, states that, on account of continued illness, Mr. E. W. Tipple is retiring from the position of chief of design. His assistant, Mr. H. F. Knight, has been appointed to succeed him.

MR. D. MACMILLAN has been appointed to the staff of J. Stone and Co. (Charlton), Ltd., and as from March 1st he will handle its marine sales in Scotland from the office at 12, Bulldale Street, Yoker, Glasgow, W.4.

MANNEX, Ltd., states that its engineering and plant division has been reorganised under the title of D.M.M. (Machinery), Ltd., 119, Victoria Street, London, S.W.1. The new company acts as representative in this country for the following German firms: Demag A.G., Maschinenfabrik Meer A.G., Miag Fahrzeugbau, G.m.b.H., and Carl Canzler.

Launches and Trial Trips

BRITISH LADY, motor tanker; built by Smith's Dock Company, Ltd., for the British Tanker Company, Ltd.; length b.p. 400ft, breadth moulded 56ft, depth moulded 30ft 1in, deadweight 8400 tons; Hawthorn-Doxford oil engine, three cylinders, 2500 b.h.p. at 108 r.p.m. Launch, January 24th.

BRIMSDOWN, steam collier; built by Burntisland Shipbuilding Company, Ltd., for the British Electricity Authority; length between perpendiculars 257ft, breadth moulded 39ft 6in, depth moulded 18ft 6in, deadweight 2680 tons; direct-acting triple-expansion steam engine, taking steam from a cylindrical multitubular boiler, 800 i.h.p. at 78 r.p.m. Launch, February 6th.

DERRYMORE, cargo vessel; built by the Burntisland Shipbuilding Company, Ltd., for McCowen and Gross, Ltd.; length 435ft, breadth moulded 60ft, depth moulded to shelter deck 39ft 6in, deadweight 10,600 tons; Hawthorn-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 4400 b.h.p. Launch, February 7th.

BRITISH GUIDE, motor tanker; built by the Furness Shipbuilding Company, Ltd., for the British Tanker Company, Ltd.; length overall 490ft 10in., breadth moulded 61ft 9in, depth moulded 33ft 11in, deadweight 12,200 tons; Hawthorn-Doxford oil engine, four cylinders, 600mm diameter by 2320mm combined stroke, 3100 b.h.p. Launch, February 7th.

WAIMATE, cargo vessel; built by Henry Robb, Ltd., for the Union Steamship Company of New Zealand, Ltd.; length between perpendiculars 325ft, breadth moulded 50ft, depth moulded 26ft, deadweight 5170 tons; two British Polar oil engines, eight cylinders, British Thomson-Houston single reduction, twin pinion, single wheel gear-box with magnetic couplings. Launch, February 8th.

ORKDAL, motor tanker; built by Harland and Wolff, Ltd., for Moltzan and Christensen, Oslo; length between perpendiculars 460ft, breadth moulded 59ft, depth moulded 34ft 10in, deadweight 12,000 tons; Harland-Burmeister and Wain diesel engine, six cylinders, 740mm diameter by 1500mm stroke. Launch, February 8th.

Catalogues

HENRY LINDSAY, Ltd., Bradford.—1950 edition of the Lindapter catalogue.

RICHARD SUTCLIFFE, Ltd., Universal Works, Horbury, Wakefield.—Belt preservation handbook.

METALASTIK, Ltd., Evington Valley Road, Leicester.—Illustrated "Metalastik Bush Catalogue, 1950."

WM. KENYON AND SONS, Ltd., Dukinfield, Cheshire.—Leaflet describing the uses of "Kisol Vermiculite."

BRITISH JEFFREY-DIAMOND, Ltd., Stenard Works, Wakefield, Yorkshire.—Folder No. 1478, dealing with the "Universal B.S. Plug."

H.E.B. MACHINE TOOLS, Ltd., 79, Portland Place, London, W.1.—Illustrated leaflet describing the "H.E.B. Hydraulic Copying Lathes."

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., 95, Aldwych, London, W.C.2.—Booklet No. 477, entitled "Manufactures and Supplies."

EDGAR VAUGHAN AND CO., Ltd., Legge Street, Birmingham, 4.—Booklet dealing with "Antisep Metal Cutting Oil Base Miscible with Water."

SAFETY PRODUCTS, Ltd., St. George's House, 44, Hatton Garden, London, E.C.1.—Pamphlet giving particulars of the "Pulsafe Uno Goggle."

British Patent Specifications

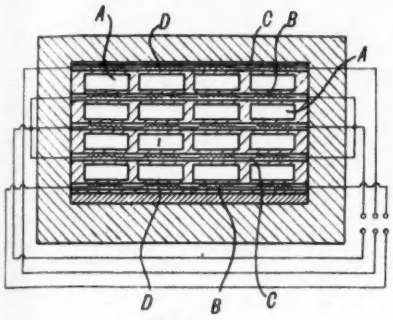
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

ELECTRICAL ENGINEERING

648,992. March 15, 1948.—TUNNEL FURNACE, Louis Gottignies, of 19, Avenue de la Joyeuse Entrée, Brussels, Belgium, and Rodolphe Gottignies, of 12, rue Michel Chasles, Paris, France.

The electric tunnel furnace described in this specification has its resistances arranged to compensate for heat losses through outer walls of the furnace. The furnace comprises a number of tunnels *A* separated from one another by partitions. Each tunnel is heated by means of resistances *B* arranged transversely in the roof and floor. The resistances are preferably of equal length and take the form of helices of wire housed in channels, formed in the partitions. Straight wires *C* or helices of very large pitch, connect the resistances, which are arranged to compensate for heat losses through outer walls of the furnace.



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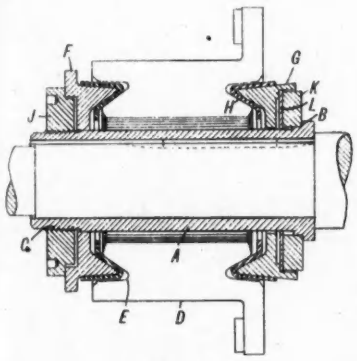
Resistances *D* are provided to heat tunnels adjoining the outer walls of the furnace. In this case the upper and lower exterior wall resistances are arranged to compensate for larger heat losses than the resistances provided to heat the other tunnels. To this end the helices in the roofs of the upper tunnels and in the floors of the lower tunnels are of lower resistance than the other helices. The resistances disposed in the floors or in the roofs of a row of adjacent tunnels are connected in series. Moreover, the uppermost and lowermost series of resistances are fed independently of the other series, which may, for example, be connected in parallel, as shown. In another arrangement illustrated in the specification, supplementary resistances are placed in outer walls of the furnace.—*January* 17, 1951.

647,326. November 2, 1948.—IMPROVEMENTS IN AND RELATING TO COMMUTATORS FOR DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

The drawing shows a sectional view of a commutator assembly. Keyed to the shaft so as to be rotatable with it is an annular commutator sleeve *A* provided with a shoulder *B* at one end and a



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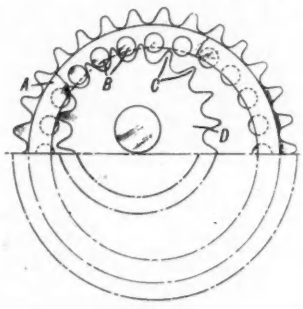
threaded portion *C* at the other. Commutator segments *D* have V-shaped notches *E* at their ends and are held in place by two V-rings *F* and *G*, with insulation *H* interposed between the V-rings and the commutator segments. Means including a threaded nut *J* on the commutator sleeve and an annular resilient ring *K* biased against the shoulder *B* are provided for drawing together the V-rings. The resilient spring ring *K* is made of a flexible material, such as steel, to restrain the V-ring members against axial motion relative to each other. Interposed between spring ring *K* and the shoulder of the movable V-ring *G* is a centring washer *L*. This centring washer is a diaphragm of flexible material and fits tightly between an inner periphery of the movable V-ring and an outer periphery of the commutator sleeve. The centring washer allows the V-ring to move axially in either direction under the various conditions of commutator operation, and at the same time preserves exact concentricity. In this construction there is no frictional resistance between the parts, the movable V-ring riding perfectly centred on the flexible diaphragm. The relatively small amount of axial motion does not disturb this centring alignment and the movable V-ring stays centred under all temperature conditions.—*December* 30, 1950.

MISCELLANEOUS

649,235. November 26, 1948.—IMPROVEMENTS IN OR RELATING TO TOOTHED GEAR DEVICES COMPRISING AN ANNULAR FLOATING GEAR WHEEL, Northern Patent Developments, Ltd., of 36, Priestgate, Darlington, and Benson George Willis Bartlett, of 1, Cartmell Terrace, Brinkburn Road, Darlington.

As shown in the drawing, the teeth on the internally toothed annular floating member *A* are provided by integrally formed circular bosses *B*, the teeth co-acting with teeth *C* of normal construction on the externally toothed sprocket *D*. The teeth *B* fit closely in the space between two adjacent teeth *C* of the sprocket *D*. There is no backlash between the intermeshing



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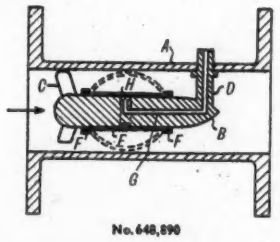
teeth, and the extent of penetration of the teeth of the internally toothed floating member into those of the externally toothed sprocket will be determined. The circular teeth will not touch the roots of the other teeth, bottom clearance being retained. In an alternative construction described in the specification, the circular teeth are provided with rollers mounted on spindles which are pins having stepped ends. The portion passing through the roller is of larger diameter than the end portions journalled into the sides of the gear member; the sides may form shrouds to the teeth formed by the rollers.—*January* 24, 1951.

648,890. July 3, 1947.—A FLUID-FLOW REGULATING VALVE, Papierfabrik Balsthal A.G., of Balsthal, Switzerland.

As shown in the accompanying drawing, the invention consists of a tube *A*, through which the fluid passes in the direction of the arrow. In this tube is mounted a streamlined member *B*, which



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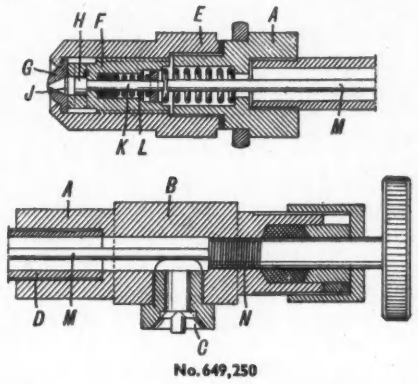
is kept in its place by projections *C* and a pipe *D* formed integral with *B*. On this member a rubber tube *E* is secured by means of clamping strips *F*. The passage in pipe *D* is continued by a passage *G* emerging into an annular chamber *H*. If pipe *D* is connected to a suitable fluid pressure source, the rubber tube will assume the position shown in dotted lines. The regulating pressure which is supplied through the pipe *D* may be adjusted in any other suitable way.—*January* 17, 1951.

649,250. December 29, 1949.—ATOMISER FOR LIQUIDS, Karl Olsen Grönlind, of Hoffsveien 15, Sköyen near Oslo, Norway.

The invention is characterised in that the throttling member of the atomiser is spring-loaded to move rearwardly and is adapted to be pressed forward by a separate rod, which can be adjusted axially by external means. In the accompanying drawing, the upper view shows the front portion and the lower view the rear portion of the complete atomiser. The atomiser *A* has an inlet connection *B* for the liquid, which is conducted into the opening *C* and continues through the pipe *D*, which ends in the atomising housing *E*. In the latter a whirling screw *F* has in front of it an apertured atomising disc *G*. The whirling screw is provided with a piston *H* in the compartment *J*. The piston-rod *K* passes through the screw and is held forward by a spring *L*. The piston, when displaced



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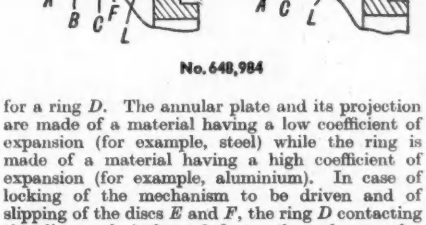
axially, increases or decreases the effective area of the grooves or channels through which the liquid is pressed into the compartment *J*. The piston is moved against the disc by a rod *M* which may be advanced or retracted by the adjusting screw *N*.

The axial depth of the grooves or channels in the whirling screw *F* determines the capacity of the atomiser, which may, by axial adjustment of the piston *H*, be regulated over the whole capacity range. For larger capacities, for instance, 300kg of fuel fed per hour, it is not necessary to regulate over the whole range from a minimum up to 300kg. In such case, the regulation may preferably comprise, for instance, only the range 150–300, so that below 150 there is no regulation. This result may be obtained by arranging in the front end of the screw *F* tangential grooves similar to the main grooves or channels, but of less depth and without the provision of wings on the piston. Means are provided to ensure that the quantity of fuel which the piston allows to pass shall not be less than a certain minimum limit.—*January* 24, 1951.

POWER TRANSMISSION

648,984. January 28, 1948.—IMPROVEMENTS IN AND RELATING TO THERMALLY RELEASABLE TORQUE-LIMITING CLUTCH, Francois Linder, 32, Rue des Aubepines, Bois-Colombes (Seine), France.

According to the invention, as shown in the drawing, the annular plate *A* is formed with an annular projection *B* having a shoulder *C* acting as a support



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for a ring *D*. The annular plate and its projection are made of a material having a low coefficient of expansion (for example, steel) while the ring is made of a material having a high coefficient of expansion (for example, aluminium). In case of locking of the mechanism to be driven and of slipping of the discs *E* and *F*, the ring *D* contacting the disc pack is heated faster than the annular plate and will expand more rapidly. At a certain temperature the ring will clear the shoulder *C* and the annular plate *A* will come into abutment with locking ring *G*, the discs will be no longer subjected to the action of the springs *H*, thus permitting a free relative rotation of the members *K* and *L*.—*January* 17, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Sat., Feb. 17th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Electronics," J. E. Fielden, 7.30 p.m.

Mon., Feb. 19th.—CENTRAL LONDON BRANCH: St. Ermin's Hotel, London, S.W.1, "Mercury Arc Rectifiers," K. B. Blake, 6.50 p.m.

Tues., Feb. 20th.—LONDON BRANCH: Lighting Service Bureau, 2, Savoy Hill, W.C.2, "Accidents and the Supervising Electrical Engineer's Responsibilities," E. Midgley, 6.30 p.m.

Wed., Feb. 21st.—COVENTRY BRANCH: Technical College, The Butts, Coventry, "Interference: Its Causes and Remedy," J. C. E. Pastance and E. R. Robson, 7.15 p.m.——MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "The Other Fellow's Job," (Lecturettes) 7.30 p.m.

Thurs., Feb. 22nd.—LUTON BRANCH: George Hotel, George Street, Luton, Lecture on "Flowmeters," 8 p.m.

British Institute of Management

Tues., Feb. 20th.—Management House, 8, Hill Street, London, W.1, "Organisation and Methods in Industry," J. J. Gracie, 5.30 p.m.

British Institution of Radio Engineers

Wed., Feb. 21st.—LONDON SECTION: School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "Electronics and Air Transport," C. H. Jackson, 6.30 p.m.

Engineer Buyers' and Representatives' Association

Thurs., Feb. 22nd.—Visit to the Brush Electrical Engineering Company, Ltd., Loughborough, 10.30 a.m.

Illuminating Engineering Society

Tues., Feb. 20th.—LIVERPOOL CENTRE: Electricity Board's Service Centre, Whitechapel, Liverpool, 1, "The Operation and Maintenance of Fluorescent Lighting Installations," G. D. Jones-Thomas and W. A. R. Stoyle, 6 p.m.

Thurs., Feb. 22nd.—BRADFORD GROUP: Yorkshire Electricity Board, 45/53, Sunbridge Road, Bradford, "Sight and Light," J. Benson, 7.30 p.m.

Incorporated Plant Engineers

Tues., Feb. 20th.—GLASGOW BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, "Choice and Installation of Temperature Measuring Instruments," A. Stewart, 7 p.m.

Wed., Feb. 21st.—WESTERN BRANCH: Grand Hotel, Bristol, "Electrical Distribution," R. H. Cobbold, 7.15 p.m.

Thurs., Feb. 22nd.—S. YORKS BRANCH: Grand Hotel, Sheffield, "Industrial Ventilation," 7.30 p.m.

Institute of British Foundrymen

Tues., Feb. 20th.—COVENTRY AND DISTRICT STUDENTS' SECTION: Technical College, Coventry, "Pig Iron Production," 7.15 p.m.

Institute of Fuel

Tues., Feb. 20th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Developments in the Firing of Shell Boilers by Means of Chain-Grate Stokers," C. H. G. Hayward, 5.30 p.m.

Institute of Industrial Supervisors

Thurs., Feb. 22nd.—ROTHERHAM SECTION: College of Technology, Howard Street, Rotherham, "Man Management," C. W. Mustill, 7.30 p.m.——NEWARK-ON-TRENT SECTION: County Technical College, Newark, Industrial Film Show, including "Industrial Handling," 7.30 p.m.

Fri., Feb. 23rd.—CARDIFF SECTION: Technical College, Cardiff, "The Foreman and Productivity," B. H. Dyson, 7 p.m.

Institute of Navigation

To-day, Feb. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The American Plan for Air Traffic Control," D. O. Fraser, 5 p.m.

Institute of Physics

Tues., Feb. 20th.—ELECTRONICS GROUP: 47, Belgrave Square, London, S.W.1, discussion on "Electronics and the M.K.S. System of Units," opened by G. F. Nicholson, 5.30 p.m.

Institute of Road Transport Engineers

To-day, Feb. 16th.—S. WALES GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, "The Manufacture and Performance of Brake Linings," J. G. Remington, 7 p.m.

Mon., Feb. 19th.—MIDLANDS CENTRE: Crown Inn, Broad Street, Birmingham, "Brakes and Clutches," Ivan M. Waller, 7.30 p.m.

Tues., Feb. 20th.—N.E. CENTRE: Dunelm Hotel, Old Elvet, Durham, "Fuel Injection Equipment," C. L. Edwards, 7 p.m.

Institution of Chemical Engineers

Sat., Feb. 17th.—N. WESTERN BRANCH: The University, Leeds, "A Mechanical Analogue for the Solution of Distillation and Other Separation Problems," N. L. Franklin, J. S. Forsyth and H. Winning, 2.30 p.m.

Institution of Civil Engineers

Tues., Feb. 20th.—Great George Street, S.W.1, discussion, "Pile Driving in Difficult Conditions," S. Packshaw, 5.30 p.m.

Wed., Feb. 21st.—MIDLANDS ASSOCIATION: The College, Loughborough, "Second Thoughts on Some Points in the Design of Coleshill Sewage Purification Works," M. R. Vincent Davis, 7 p.m.

Institution of Electrical Engineers

Mon., Feb. 19th.—RADIO SECTION: Savoy Place, Victoria Embankment, W.C.2, discussion on "Is There an Optimum Speed for a Gramophone Record?" opened by G. F. Dutton, 5.30 p.m.——N.E. CENTRE: King's College, Newcastle-upon-Tyne, "A Simplified Method for Checking the Orientation of the Optic Axis of Meter Jewels," and "A Sensitive Balance for Stability Tests on Permanent Magnets," S. F. Knight, 6.15 p.m.

Tues., Feb. 20th.—LONDON STUDENTS' SECTION: Savoy Place, Victoria Embankment, W.C.2, "Parallel Conductors," E. J. Holmes, 7 p.m.——S. MIDLAND CENTRE: Winter Gardens, Great Malvern, "Some Electrical Methods of Measuring Mechanical Quantities," F. J. Woodcock, 7 p.m.——N. MIDLAND CENTRE: Lighting Service Bureau, 24, Aire Street, Leeds, 1, "The Cost and Efficiency of Earthing on Low and Medium-Voltage Overhead Line Systems," L. Gosland, 6.30 p.m.

Wed., Feb. 21st.—SUPPLY SECTION: Savoy Place, Victoria Embankment, W.C.2, "Transient Theory of Synchronous Generators Connected to Power Systems," B. Adkins, 5.30 p.m.

Institution of Heating and Ventilating Engineers

Wed., Feb. 21st.—LONDON AND DISTRICT ASSOCIATE MEMBERS AND GRADUATES' SECTION: Demonstration Theatre, 178–180, Edgware Road, W.2, "Methods of Cooling Air," H. Bell, 6.30 p.m.

Fri., Feb. 23rd.—MANCHESTER AND DISTRICT BRANCH: Town Hall, Manchester, Chairman's Address, 6.30 p.m.

Institution of Locomotive Engineers

Wed., Feb. 21st.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Modernisation of a Large Motive Power Depot, Polmadie, Scottish Region," R. F. Harvey, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Feb. 16th.—Storey's Gate, St. James's Park, S.W.1, "The Aviation Engine," F. R. Banks, 5.30 p.m.

Mon., Feb. 19th.—MIDLAND BRANCH, GRADUATES' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Control of Industrial Processes by Weight," M. C. Hawkings, 7 p.m.——SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Lightweight Bus Body," Group-Capt. McIntyre, 7.30 p.m.

Wed., Feb. 21st.—WESTERN BRANCH: Guildhall, Salisbury, "The Provision of Technological Courses in Universities, Technical Colleges and National Colleges," D. S. Anderson, 6.30 p.m.——COVENTRY A.D. CENTRE, GRADUATES' SECTION: Hare and Squirrel Hotel, Union Street, Coventry, Annual Debate Evening, 7.30 p.m.—N.E. A.D. CENTRE: University Chemistry Lecture Theatre, Leeds, "The Use of Wire-Resistance Strain Gauges in Automobile Engineering, with Particular Reference to Strain in Vehicle Structures," J. R. Bristow, P. Metcalf and C. H. G. Mills, 7.30 p.m.

Thurs., Feb. 22nd.—N.W. BRANCH: College of Technology, Manchester, "Supercharging of Internal Combustion Engines," Sir Harry R. Ricardo, 6.45 p.m.——WESTERN A.D. CENTRE: Royal Hotel, Bristol, Address by the Centre Chairman, G. J. Brown, 6.45 p.m.——LONDON GRADUATES' SECTION: Storey's Gate, St. James's Park, S.W.1, discussion on "A Modern Aerodrome," 6.30 p.m.

Fri., Feb. 23rd.—Storey's Gate, St. James's Park, S.W.1, discussion on "Fatigue Tests," 5.30 p.m.

Institution of Post Office Electrical Engineers

Wed., Feb. 21st.—Conference Room, Fourth Floor, Waterloo Bridge House, S.E.1, "Public Speaking," A. K. Robinson, 5 p.m.

Institution of Production Engineers

To-day, Feb. 16th.—E. COUNTIES SECTION: Public Library, Ipswich, "Measurement of Productivity," R. G. Hooker, 7.30 p.m.

Mon., Feb. 19th.—N.E. SECTION: Neville Hall, Westgate Road, Newcastle-upon-Tyne, "Practical Application of Tungsten Carbide," H. Eckersley, 7 p.m.——MANCHESTER SECTION: College of Technology, Sackville Street, Manchester, "Mechanical Handling, with Special Reference to the Textile Industry," F. T. Dean, 7.15 p.m.

Tues., Feb. 20th.—COVENTRY SECTION: Geisha Cafe, Hertford Street, Coventry, "Measurement of Productivity," Walter C. Puckey, 7.15 p.m.——LONDON GRADUATE SECTION: Visit to Hilger and Watts, Ltd., 48, Addington Square, London, S.E.5, 2.30 p.m.

Wed., Feb. 21st.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Steel Company of Wales, Ltd.—Developments at Port Talbot," 7 p.m.——EDINBURGH SECTION: North British Station Hotel, Edinburgh, "The Legal Side of Industry," H. Harman, 7.30 p.m.——N. IRELAND SECTION: Municipal College of Technology, Belfast, "Marking Devices for Engineers," A. Throp, 7.30 p.m.

Thurs., Feb. 22nd.—LEICESTER SECTION: College of Art and Technology, The Newarke, Leicester, "The Lost Wax Process," A. Short, 7 p.m.

Institution of Structural Engineers

Thurs., Feb. 22nd.—11, Upper Belgrave Street, S.W.1, "Building on Fill, with Special Reference to the Settlement of a Large Factory," G. G. Meyerhof, 5.55 p.m.

Fri., Feb. 23rd.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Distribution Methods of Structural Analysis," A. J. Francis, 6 p.m.

Iron and Steel Institute

Tues., Feb. 20th.—Institution of Civil Engineers, Great George Street, S.W.1, Fifth Hatfield Memorial Lecture, "Turbine Problems in the Development of the Whittle Engine," Sir F. Whittle, 8.30 p.m.

Junior Institution of Engineers

Fri., Feb. 23rd.—39, Victoria Street, London, S.W.1, "Sundials," Laurence H. A. Carr, 6.30 p.m.——SHEFFIELD AND DISTRICT SECTION: Grand Hotel, Sheffield, "Some Recent Examples of Centralised Lubrication Systems," S. J. Norton, 7.30 p.m.

Liverpool Engineering Society

Mon., Feb. 19th.—Royal Institution, Colquitt Street, Liverpool, "Installations in Large Chemical Factories," D. B. Hogg, 6.30 p.m.

Liverpool Metallurgical Society

Wed., Feb. 21st.—Visit to the works of the Manganese Bronze and Brass Company, Birkenhead, 2.30 p.m.

Manchester Association of Engineers

To-day, Feb. 16th.—Engineers' Club, Albert Square, Manchester, "Modern Methods of Painting Machinery and Workshops," S. A. Wood, 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Fri., Feb. 23rd.—Neville Hall, Westgate Road, Newcastle-upon-Tyne, "A Comprehensive Series of Vibration Tests on the S.S. 'Clan Alpine' and the S.S. 'Ocean Vulcan,'" A. J. Johnson, 6.15 p.m.

Royal Aeronautical Society

Fri., Feb. 23rd.—Institution of Civil Engineers, Great George Street, S.W.1, "Power versus Weight in Aviation," M. Roy, 6 p.m.

Royal Institution of Chartered Surveyors

Mon., Feb. 19th.—12, Great George Street, Westminster, S.W.1, "The Problems of Development Plans," E. H. Doubleday, 5.30 p.m.

Royal Meteorological Society

Wed., Feb. 21st.—49, Cromwell Road, London, S.W.7, discussion on "Recent Work on the Stratosphere," 5 p.m.

Sheffield Society of Engineers and Metallurgists

Mon., Feb. 19th.—Royal Victoria Station Hotel, Sheffield, "Some Aspects of Modern Steelmaking," A. Robinson, 6.15 p.m.

Stephenson Locomotive Society

Sat., Feb. 17th.—N.E. AREA: 18, Lovaine Place, Newcastle-upon-Tyne, Annual General Meeting, 6.30 p.m.——LIVERPOOL CENTRE: Central Station Offices, Room 35, Liverpool, "Brighton Works and Locomotives, 1922–24," E. M. S. Wood, 7 p.m.

Codes of Practice

The Codes of Practice Committee for Civil Engineering, Public Works and Building and Constructional Work is under the ægis of the Ministry of Works. Codes are issued on behalf of the Committee by the British Standards Institution, 24–28, Victoria Street, London, S.W.1.

INTERNAL COVERINGS AND RIGID INFILLINGS

Sub-Codes 124.301, 124.309 and 124.401, "Timber Coverings (Internal), Cork Slab Coverings (Internal) and Rigid Infillings for Framed Partitions" have now been issued for comment in a single document consisting of the three sub-codes, each of which should be read in conjunction with Code 124, "Walls and Partitions of Framed Construction (External and Internal)." The code is in draft form and is subject to amendment in the light of comments which should be submitted by February 24, 1951.

FOURTH REPORT OF THE CODES OF PRACTICE COUNCIL

The fourth report of the Council for Codes of Practice for Buildings covers the period January, 1947 to December, 1949. Previous reports covered the period from the establishment of the Council in 1942 (then known as the Codes of Practice Committee) until December, 1946. The fourth report records the appointment, early in 1948, of a sub-committee to review the organisation, and the adoption of its recommendations on the best method of continuing the work. The Codes of Practice Committee was renamed the "Council for Codes of Practice for Buildings—Construction and Engineering Services." The Civil Engineering and Public Works Codes were removed from the programme and the number of Codes was reduced, so that a modified programme could be completed within 2 to 2½ years. Changes in drafting procedure were made to accelerate the production. By the end of 1949 forty-five Codes had been published in final form after comment, and 148 issued for comment. The programme, given in an appendix to the report, envisages the production of ten Chapters of the Code of Functional Requirements of Buildings, and 224 General Series Codes, including groups of Sub-Codes.

Some account is given of arrangements for making known the work of the Council, through lectures to various interested associations and bodies, and through the agency of the Ministry of Works by the use of a travelling exhibition and a display shown at the Building Centres in London and Glasgow. The report, which contains a list of members of the Council, and the Sectional and Code and Drafting Committees, will be of interest to all concerned with the building industry. It is a testimony, the Council states, to the continuance of the co-operation that alone makes possible the production of Codes of Practice. It is published by H.M. Stationery Office, at a price of 1s.